ED 027 562 CG 003 454

By-Freeman, James; And Others

Creativity--A Selective Review of Research. Research into Higher Education Monographs.

Society for Research into Higher Education, Ltd., London (England).

Pub Date Nov 68

Note-120p.

Available from-Society for Research into Higher Education Ltd., 2 Woburn Square, London WC 1, 21 shillings.

EDRS Price MF-$0.50 HC-$6.10

Descriptors-*Creative Development, *Creativity, *Creativity Research, Environmental Influences, Environmental Research, Intellectual Development, Originality, Self Expression, *Thought Processes

Largely as a result of the extensive work carried out during the past decade, the concept of creativity has become increasingly important in educational and psychological thinking. This monography attempts to impose a framework within which to describe the main varieties of research on creativity. The monograph includes the following areas as chapters: (1) creativity as related to intelligence and personality; (2) special abilities in creativity, the structure of intellect; (3) special abilities in creativity, some research into convergent and divergent thinking; (4) educational factors in creativity in terms of observed psychological differences between individuals. A selected bibliography intended to facilitate further inquiry is grouped into the following sections: (1) general and theoretical analyses of creativity, (2) studies of creativity in the arts and sciences, (3) personality and intellectual characteristics in creativity, (4) the development of creativity, (5) environmental studies, (6) studies of problem-solving in creativity, (7) group processes and group effectiveness in creativity, (8) tests and measurements, and (9) research reports prepared by the Aptitudes Research Project, University of Southern California. (IM)

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CREATIVITY

a selective review of research

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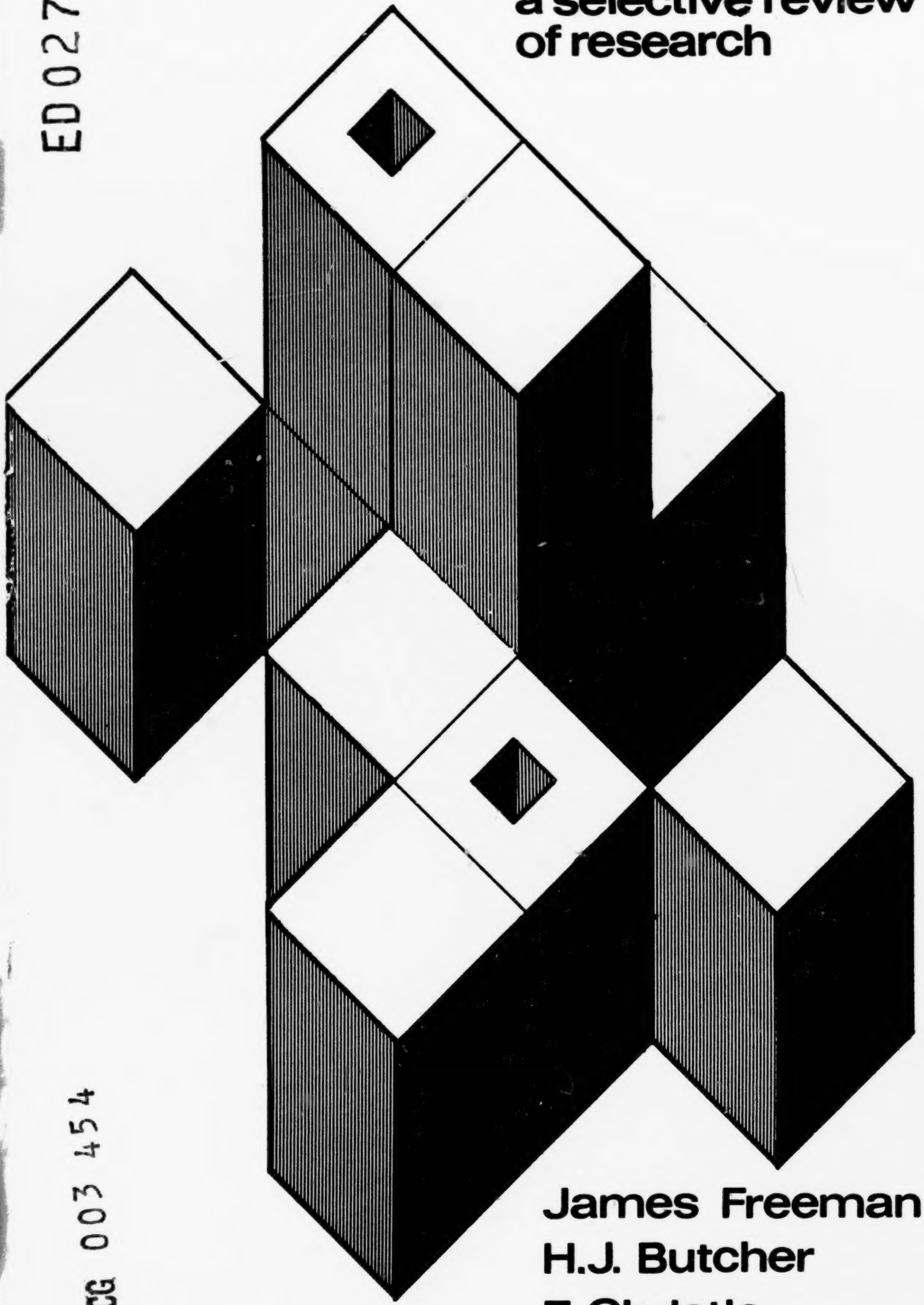

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James Freeman
H.J. Butcher
T. Christie

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Price: 21/-

CREATIVITY

A SELECTIVE REVIEW OF RESEARCH

by

James Freeman, BA, PhD
H. J. Butcher, BA, PhD
T. Christie, MA, BEd

Society for Research into Higher Education Ltd.,
2 Woburn Square, London WC1.

November 1968

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION

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JAMES FREEMAN graduated in Philosophy and Psychology at Hull University in 1959 obtaining a University Exhibition and Collingwood Philosophy Prize. After completing three years' research in experimental psychology he went on to work for a year with Henri Tajfel at Oxford University. He joined the University Education Research Project at Manchester in 1964, and in 1965 he helped found the Education in Architecture Unit in which he is now research associate.

Before taking up the new Chair of Higher Education in the University of Manchester in 1967, H.J. BUTCHER was a lecturer in Education in the same university (1956-1963), a lecturer in Psychology, University of Edinburgh (1963-1967) and Deputy Director of the Godfrey Thomson Unit for Educational Research. He has already published several works on creativity and intelligence in collaboration with Professor R.B. Cattell at the University of Illinois.

T. CHRISTIE has been lecturer in Education at the University of Manchester since 1965. Prior to this he was research associate on the large-scale sixth form survey carried out by the Department of Education, University of Manchester.

The cover design is by T.M. SMITH.

CONTENTS

Page

Chapter 1. INTRODUCTION 1

General 1
(a) Subject matter 3
(b) Methods of investigation 3
(c) Kinds of theoretical approach 4

Chapter 2. CREATIVITY AS RELATED TO INTELLIGENCE AND PERSONALITY 9

Chapter 3. SPECIAL ABILITIES IN CREATIVITY : THE STRUCTURE OF INTELLECT 20

Chapter 4. SPECIAL ABILITIES IN CREATIVITY : SOME RESEARCH INTO CONVERGENT AND DIVERGENT THINKING 28

(a) Introduction to the test 28
(b) Administering and scoring the test 29
(c) Discussion of results 36

Chapter 5. EDUCATIONAL FACTORS IN CREATIVITY 41

(a) Introduction 41
(b) Institutional factors 41
(c) The stages of creative activity 45
(d) The concept of 'set' 47
(e) The intolerance of ambiguity 53
(f) Deferred judgment 56

Chapter 6. CREATIVITY AND ENVIRONMENT 60

REFERENCES 74

A SELECTED BIBLIOGRAPHY 86

ACKNOWLEDGEMENTS

During the Summer Term of 1966 one of the authors visited a number of the major institutions of higher education in the United States with a view to collecting first-hand information on developments in the field of 'creativity'. The material collected has made a most substantial contribution to this monograph.

The authors are particularly grateful to Professor J.P. Guilford for his kindness in sending us papers and offprints and also for his hospitality on the visit to the Aptitudes Research Project, University of Southern California.

In a similar way our thanks are due to Professor T.R. McConnell and his colleagues at the Center for the Study of Higher Education, Berkeley, California. We were given a detailed account of the impressive research being carried out at Berkeley. Professor D.W. MacKinnon discussed his work on creativity at the Institute of Personality Assessment and Research, and supplied a number of offprints.

Professor R.B. Cattell described some of the research in progress at the University of Illinois and supplied some important research reports. Professor Lester Anderson organised our visit to the Creative Education Foundation at Buffalo where Professor Sidney Parnes gave us a collection of offprints of his research in creativity. Professor B.R. Bugelski also gave us an interesting account of some of his work.

Mr. Michael Hartley, editor of the International Journal of Electrical Engineering Education, kindly gave us his permission to reproduce results and findings from a report published in his journal. We thank him for his comments and suggestions which were most valuable in the extension of our own research into the field of electrical engineering.

Our colleague, Mr. J.G. M'Comisky, constructed the psychological test described in Chapter 4. We thank him for the independent research data he made available to us.

Finally, we would like to thank Mrs. Winifred Rowles, Miss Nita Boothby, and Miss Josephine Vickers for typing the manuscript.

J. Freeman
H.J. Butcher
T. Christie

Chapter 1. INTRODUCTION

GENERAL

Unlike most of the monographs in this series, the present one will not be confined to research into higher education. But the research reviewed has obvious implications for higher education and some of it is directly relevant. A further restriction we must mention is that, faced with the vast range of literature on the subject (mainly American and mainly published in the last fifteen years) we have been forced to select; this selection has been largely but not exclusively guided by an intention to review studies dealing with creativity in terms of observed psychological differences between individuals and to give less emphasis to environmental and sociological research.

An easily identified starting-point for much of the recent wave of enthusiasm for the subject was the inaugural address to the American Psychological Association in which J. P. Guilford (1950) drew attention to "education's appalling neglect of the study of creativity" and went on to indicate that of some 121,000 titles indexed in Psychological Abstracts up to 1950, only 186 dealt with the topic. Since that date there has been a great spate of research into 'creativity' and related subjects. In the United States, in particular, there has been a steadily increasing number of studies devoted to "the identification of the creative student" and to "the nurture of creative talents and abilities". Some examples of well known, large-scale reports are: MacKinnon (1962-a) The Nature and Nurture of Creative Talent; Taylor et al. (1960) Widening Horizons in Creativity; Taylor and Barron (1963) Scientific Creativity: its Recognition and Development; Torrance (1962) Guiding Creative Talent; Heist et al. (1967) Education for Creativity; Guilford (1959) Three Faces of Intellect; Getzels and Jackson (1962) Creativity and Intelligence; Wallach and Kogan (1965) Modes of Thinking in Young Children.

The research mentioned above is all American. British and Continental work has, in general, been carried out on a smaller scale and in relative isolation, a possible exception being the work of Hudson (1966). We attempt to show, however, that some of the contemporary and earlier research (both American and European) in the fields of intelligence, ability and thinking, has a direct bearing on creativity although this research seldom treats the topic exclusively. Important examples are the work of Bartlett (1932), Burt (1949), Spearman (1927), Thurstone (1938), Bruner (1956), Hebb (1949), Harlow (1949), Piaget (1947) and Vygotsky (1962).

Largely as a direct result of the extensive work carried out during the past decade or so the concept of creativity has become important, sometimes indeed almost a cult, in educational and psychological thinking. Even the most perfunctory semantic analysis, however, suggests that this concept as commonly employed is amorphous and indefinite; its relationship with longerestablished concepts in education and psychology is vague and loose and its use by both educators and psychologists highly individualistic. Current views on the nature of creativity differ widely and cannot easily be separated from views on intelligence and intelligence testing, the assessment of special aptitudes and abilities, learning theory, personality theory, and the psychology of thinking. There is as yet no unified psychological theory of creativity available to the research worker or the educational practitioner.

But despite the fact that the concept of creativity is so amorphous it is also highly useful. Its present lack of preciseness need not preclude it from eventually proving valuable as a scientific concept. The immaturity of research in this field is due partly to the sheer novelty of concentrated empirical investigation and this in turn is due to the difficulty of studying such multifarious and high-level phenomena. There can be little doubt that the phenomena are real and important though in the past they have been described in various and mainly subjective terms.

Concepts such as 'imagination', 'ingenuity', 'innovation', 'intuition', 'invention and discovery', and 'originality', all of which have strong family resemblances, have often been used synonymously with 'creativity'. A reasonable way of looking at the relationship between creativity and such concepts is as a collective or 'class' relationship, analogous to the way in which the concept 'plane-figure' is related to the concepts 'triangle', 'square', 'parallelogram', tc.

A more detailed semantic analysis and perhaps an attempt at operational definition are of particular importance in creativity research since the study of creativity is clearly related (though the relations are still arguable) to such central fields of psychology as intelligence and ability, personality theory, learning theory, the psychology of thinking and probably several others. An increasing specialisation in these topics has led, perhaps inevitably, to departmentalization of study and often to an unduly exclusive concentration on relatively narrow problems. Creativity research has become particularly important since it has tended to draw ideas from all of these fields. In so doing, it has punched some holes in the water-tight compartments that have been thrown up between, for instance, cognitive and non-cognitive theories of personality. This is one of the major contributions made by creativity research to general and educational psychology, that it has brought together, or at least brought closer, kinds of study that have traditionally been separated.

A consequence of this breaking down of barriers is that the whole field of study is changing rapidly and students hot for certainty are likely to be disappointed. Views even on such a basic question as the relation of creativity to intelligence oscillate to some degree with each new major research. While most psychologists would agree that there is an important relationship between creativity and intelligence they differ markedly in emphasis. Getzels and Jackson (1962), whose work is reviewed at some length in Chapter 2, were the first to maintain unequivocally and in detail that there are two distinct types of intellectual ability which differ not in degree, but in kind. They argue that the typical intelligence tests in current use, one instance of which would be the type used in the English 'eleven plus' examination, measure one kind of ability, and also tend to select children whose thinking is of an analytic or reproductive type rather than those of an intuitive or productive type. More recent research has suggested that this view represents a considerable over-simplification, but Getzels and Jackson's work has served to illuminate, in a way which it is impossible to ignore, a general dissatisfaction with the tests of intelligence and attainment in current use, and has stimulated a great deal of the re-thinking about their limitations.

This is only one example of the re-thinking necessitated by recent research. But before considering other examples we need to impose some kind of framework within which to describe the main varieties of research. This has varied widely in terms of subject matter, methodological procedures and theoretical focus and emphasis. It is essential to make at least these distinctions in any preliminary discussion. Further, more detailed, distinctions will emerge later in this account.

A. SUBJECT MATTER

The subject matter of research has included, for example:

Creativity in Art: Ecker (1963), Eindhoven and Vinacke (1952), Israeli (1962).

Creativity in Engineering: Lightman (1958), Nixon (1958).

Creativity in Literature: Ghiselin (1963), Taylor (1957), Kent (1936).

Creativity in Science: Gough and Woodward (1960), Hays (1962), Roe (1952).

These four fields are quoted as examples. Creativity in many others (e.g. architecture, music) has also been quite extensively studied.

B. METHODS OF INVESTIGATION

These differ widely and include, for instance:

Psychometric and factor-analytic techniques: Guilford (1959), Cattell (1957).

Psycho-analytical and projective methods: Kris (1952), Burchard (1952), Rapaport (1950).

The comparison of matched experimental groups: Buttle *et al*. (1965), M'Comisky and Freeman (1967), Cross, Cattell and Butcher (1967), Freeman *et al*. (1968).

Clinical and Case Studies: Pine and Holt (1960), Dax (1951), Delay (1955).

It must be pointed out that the methodological examples have been selected arbitrarily, in line perhaps with the writers' own interests. They give some indication, however, of the variety of techniques that have been used.

The determining criteria in the use and development of experimental techniques have been mainly: the facility with which it has been possible to transfer and adapt existing techniques from other related fields, e.g. from studies of intelligence, personality and learning; subject and data availability; the formulation of testable hypotheses; facility of repetition procedures; and validity and reliability of available measures. The determining criteria in the use and development of case study and clinical methods have been mainly those of the availability of subjects and subject matter; the access to relevant facts; the amenability of subjects' reports to content analysis; the accuracy and saliency of observations; the interpretation of these and their place and relevance in a general theory of creativity.

While it is true that most of the research reported in the current literature has been conducted by psychologists and educationalists using experimental and statistical methods, anyone studying the subject of creativity soon becomes aware of the value of a multiplicity of techniques and methods of approach.

In this survey our aim has been to give rather more emphasis to those methods that seem likely to be of use in the study of higher education. Within the space available we have been obliged to omit or to treat more cursorily some other lines of approach that may be equally promising (e.g. the study of young children).

C. KINDS OF THEORETICAL APPROACH

Finally, we consider the rather diverse theoretical assumptions involved in some of the relevant enquiries. Research can be classified in three main divisions, according to theoretical emphasis.

(i) Intelligence and abilities: the assessment of creative responses to psychological testing and in problem solving situations. Studies of this type often involve a general theory of the human intellect.

(ii) Personality characteristics: the identification and measurement of the personality characteristics of individuals and groups of individuals considered to be outstandingly creative.

(iii) Education and training: the investigation of educational precepts, principles and techniques conducive to the development of creative talent and aptitude.

While each of these topics is discussed in some detail below it should be stressed that the headings, such as they are, serve purely as a convenient means of distinguishing between the various contributions and grouping them to facilitate comment. The distinctions drawn represent differences only in emphasis. Few research workers have concentrated exclusively on one of the three topics mentioned above.

In general, studies emphasizing the investigation of educational and developmental factors in creativity, as in (iii) above, often tend to be extensions and corollaries of those under headings (i) and (ii). The main distinctions and controversies tend to arise between (i) and (ii). There are some notable exceptions, however. Two good examples of writers who include all three aspects (but still perhaps pay rather more attention to one) are Koestler (1962) and Cattell (1955).

Koestler (1962) in developing a special psychological theory of creative thinking - the 'bisociative response' as he terms it - includes some interesting short character sketches of creative scientists and artists. He develops a theory of the creative process which includes practical corollaries of great importance to teachers and practitioners at all educational levels.

Cattell also includes all three theoretical emphases in his work. His (1956) Objective-Analytic Personality Test Batteries include measures of special abilities while his 16PF test and the High School Personality Questionnaire (HSPQ) have been used (among many other applications) to determine the personality characteristics of creative artists and scientists. Cattell suggests that personality and temperamental differences are "more basic than special ability differences in creative work". Again, "the difference between the creative and the positive and competent individual lies far more in the realm of personality than in the realm of special ability tests." (Cattell and Drevdahl, 1955).

This opinion is also apparent in Cattell's treatment of creativity in education. He suggests that the creative person is, amongst other things, a "self sufficient introvert". Cattell argues that the American high school, in particular, has been geared to producing extroverts and "good mixers" often treating extroversion and good adjustment as synonymous. He recommends that American schools should give equal attention to introverted pupils, or perhaps rather more to redress the balance.

Some writers not only stress the importance of a multi-disciplinary method of approach but criticise work carried out with too limited an emphasis. MacKinnon, speaking in the recent conference on creativity (whose proceedings have been published by the Center for Research and Development in Higher Education, Berkeley, California, edited by Paul Heist, 1967), is among these. "We can, I believe, maximize the probability of admitting students with creative potential to college and to graduate training, but not if we merely replace intellective requirements by non-intellective demands. We must supplement tests of intellective functioning and aptitude with independent measures of extracurricular achievement and originality".

Having said this MacKinnon goes on to criticise some of the studies which we have listed under heading (i) Intelligence and abilities, above.

"However, I am not proposing that we administer to our applicants a battery of so-called tests of creativity. In recent years, Guilford (1959) has worked on the structure of intellect and identification, by factor analysis, of several dimensions of creative thinking. The work on the latter dimensions, including adaptive flexibility, originality, and sensitivity to problems, has led to a widespread hope and expectation that his tests of creative ability would provide us with reliable means for identifying creative persons. So far, however, this hope has not been realized."

MacKinnon quotes studies in which Guilford's tests of creativity have not proved efficient predictors of creative talent. He considers a more promising approach to be one which involves autobiographical questions as to past and present competencies and activities as examined in, for example, The American College Testing Programme. A further account of his work is given in chapter 2.

Although, as we have stressed, all three aspects need to be considered in any overall view of creativity, it will be convenient to consider them separately in a little more detail.

(i) Intelligence and abilities: the identification and assessment of creative responses in psychological testing and in problem solving situations.
Examples of relevant work include the study of 'intellectual flexibility'. Guilford (op. cit); 'concept attainment' and 'cognitive styles', Bruner, Goodnow and Austin (1956), M'Comisky and Freeman (1967); 'bisociation', Koestler (1962), 'Gottschaldt Figures' and 'Gestalt completion', Cattell (1956) and other measures and examples of which are those described by Vygotsky (1956), Guilford (1954) and Getzels and Jackson (1962). These types of concepts are often, particularly in the case of the major contributors, incorporated in general theories of the human intellect, as we mentioned above. Theories of this type sometimes define 'process variables' which are determinants of the types of response listed above. Two of the most fruitful of these, in terms of research value and test construction and evaluation, are the concepts of 'convergent' and 'divergent' thinking. The first involves the ability to focus or 'converge' in one's thinking on whatever factors have been determined as relevant in a given situation leading to one 'right' answer only. The second involves the capacity to range, flexibly, in the search for relevant factors in connection with a specific problem situation leading to a number, a variety, of answers.

In subsequent chapters we briefly examine the role of general intelligence (chapter 2) and one of the major theories of special abilities in creativity, that of Guilford (chapter 3). We have also included an experimental study of 'convergent' and 'divergent' thinking and a discussion of some of the extensive work in this area (chapter 4).

(ii) Personality characteristics: the identification and measurement of the personality characteristics of individuals, and groups of individuals, considered to be outstandingly creative and productive in terms of some specific criteria.
Examples of this type of approach are: Block and Peterson (1955), Barron (1959), Barron and Welsh (1952), Cattell and Drevdahl (1955), Drevdahl and Cattell (1958), Garwood (1964), Gough (1964), MacKinnon (1961), (1963a), (1965b), Munsterburg (1963) and Taylor et al. (1959).

Studies in this area have been extensive in their scope and some, in particular, have shown novelty and ingenuity in their design and administration. MacKinnon (1962a), for instance, in a large scale research programme on creative aptitude in the fields of architecture, and engineering, industrial research, mathematics, physical science and writing, administered a battery of psychological tests to selected groups of subjects in a three day assessment. A large variety of scores, measures, profiles, ratings, recorded impressions and case history reports were collected in the attempt to "discover the distinguishing characteristics of mature, creative, productive individuals". While these findings are discussed more fully below it is useful at this point to note that MacKinnon draws attention to the important consideration that it is one thing to establish the distinguishing characteristics of mature, creative individuals, but quite another to conclude that the traits of creative persons, when observed several years after school and college, also characterized these same individuals when they were students.

The literature on temperamental aspects of creativity is particularly scattered and far-ranging. In chapter 2, we summarise a small selection of important researches, including some aspects of MacKinnon's work.

(iii) Education and training: the investigation of educational precepts, principles and techniques in the development of creative talent and aptitude.

Studies falling under this head are, in general, even more tentative, desultory and inconclusive than those discussed under (i) and (ii) above. In some cases the research has essentially taken the form of an extension of the studies of special abilities in creativity and of the studies of personality characteristics. Research workers investigating special abilities have identified certain types of creative responses and gone on to identify the process variables which are responsible for and determine these responses. Education and training are seen as needed for the full development of these process variables.

Osborn, Parnes and Meadow and their co-workers at the University of Buffalo (State University of New York) in their developmental techniques of 'brainstorming' and similar processes, illustrate one kind of research in this area. Osborn (1957), (1961); Parnes (1963); Parnes and Meadow (1959), (1960). In their controversial studies these writers submit: "Perhaps the most promising area, if we are interested in what can be done to encourage creative talent to unfold, is that of experimentation with teaching procedures which will stimulate students to think independently, to test their ideas, and to communicate them to others." They draw evidence from an educational course in creative problem-solving which was inaugurated over a decade ago. Students who had taken the course, the duration of which was one session, were claimed to be superior in performance on a number of measures of creative ability to control groups of subjects. The course at Buffalo, based on the concepts outlined in Alex Osborn's (1957) textbook *Applied Imagination*, discusses perceptual, emotional and cultural blocks, 'inhibitors', to creative thinking. As a more positive measure the concept of 'deferred judgment' is also introduced. This involves the notion of deliberately separating the *production* of ideas from the process of evaluating them. The latter is considered to have an inhibiting effect. Furthermore, it is suggested that the principle of deferred judgment is most effective in group situations.

Another interesting field is the study of 'set', a fundamental concept in psychological theory. In general we may say that writers using the concept of 'set' are referring to a factor that facilitates responses for which a subject is prepared, and that tends to inhibit any competing responses. 'Set' in problem-solving has been investigated by giving the subject a number of problems which require a specific method of solution, and then presenting him with a problem which requires a different kind of approach, as by Luchins (1951).

This type of experiment limits the concept of 'set' to a particular situation. It is possible to draw a distinction between such comparatively specific 'sets', which may be attributed to the subject immediately prior to the problem-solving situation, and the more continuous and persisting 'sets', which the subject brings to bear on a whole range of problems, as investigated by Harlow (1949). Harlow calls these latter 'learning sets'.

The 'brainstorming' approach and the concept of 'set' are discussed in detail in chapter 5. Finally, chapter 6 contains a discussion of some of the environmental and cultural factors that are believed to affect the full development of potential creative ability.

Chapter 2. CREATIVITY AS RELATED TO INTELLIGENCE AND PERSONALITY

If one describes someone as intelligent or creative, one is implicitly subscribing to a psychology of traits and implying dimensions on which people can be graded as more or less intelligent and creative. It is possible to maintain that people are simply 'intelligent' or 'not intelligent', 'creative' or 'not creative' - possible, but not very convincing in view of the practical success that has resulted from assuming continuous distributions of such traits.

Granted that people differ in these ways and that a continuous gradation is required to represent individual differences, another question arises. When is it justifiable to describe two traits as distinct? In ordinary discussion we may describe one person as 'silly' and another as 'stupid'. This is a real linguistic distinction but a subtle one; the two adjectives overlap in meaning to a very large degree. If the applied psychologist were to use concepts that overlapped to this extent his task would become impossible. Such refinements may eventually be of interest, but scientific parsimony and practical convenience alike dictate a prior study of traits that are relatively few in number and independent.

The extent to which 'intelligent' and 'creative' describe independent traits is still hotly debated. Some studies suggest very little overlap, others indicate that the two are virtually indistinguishable. The main means of deciding this question empirically is by the techniques of correlation and factor analysis. Although these have been widely employed in the study of creativity and intelligence, results have been conflicting, owing partly to the presuppositions of the investigators and partly to misunderstandings about the strengths and limitations of the techniques.

One way to demonstrate the independence of creativity and intelligence would be to construct a battery of tests designed to assess creativity and another designed to assess intelligence. If the correlations between tests within each battery were high, but the correlations between tests in different batteries were low, there would be a good case for accepting the existence of distinct traits. Factor analysis of the two batteries would confirm and clarify this independence. Actual research results have more commonly revealed high correlations between tests of intelligence, low correlations between tests of creativity, and correlations between the two kinds of test that have varied from zero to very high. A brief review of some of the more important studies will show that this generalisation requires all sorts of qualifications about the kinds of tests used, the samples of people chosen, and the circumstances and atmosphere in which the test scores and other measures were obtained.

As mentioned in chapter 1, much of the experimental work on creativity has been inspired by the pioneering efforts of Guilford, and many of the tests of creativity in most frequent use originated in his laboratory. Guilford's view of intelligence, however, is a special one, which will be described in more detail in the next chapter. Briefly, in his system, intelligence is fragmented into over a hundred independent components or facets, as explained most fully in his recent book (Guilford, 1967); relatively little attention is given to the superordinate, co-ordinating aspects of intelligent behaviour. This fragmentation is so complete, and intelligence, as commonly understood both in popular usage and in the view of a large proportion of psychologists, disappears so unequivocally that Guilford's system has sometimes been described by psychologists of a different persuasion as "Hamlet without the Prince of Denmark". One of the present writers (Butcher, 1968) has summarised the evidence for the contrary view, that intelligence is a useful and almost indispensable concept and that there is ample evidence for its existence as a broad unitary trait.

Whatever the merits of the theoretical arguments, there is little doubt that tests of general intelligence, although imperfect, have proved more useful in practice than any other kind of psychological test. In the rest of this section, the relation of creativity to general intelligence will be considered in detail.

Perhaps the best known research to produce systematic evidence that creativity and intelligence might be independent traits was that of Getzels and Jackson (1962). They studied a group of children and adolescents in a private school in Chicago, whose ages ranged quite widely and whose average IQ was over 130. (In an unselected group less than three per cent would reach this level). Within this sample, they formed two contrasting sub-groups, one highly 'creative', as indicated by aggregate score on a battery of creativity tests, including some originally devised by Guilford and by Cattell, but relatively less 'intelligent'; the other group consisted of lower scorers on the creativity tests but was exceptionally 'intelligent' even by the standards of the whole sample. Getzels and Jackson then compared the two groups on numerous other characteristics, including school attainment, popularity with teachers, home background, career aspirations, degree of conformity to accepted values, sense of humour, and so on.

Interesting and suggestive differences were found in many of these respects; in particular, the 'highly creative' children appeared to have a more lively sense of humour, to come from less 'academic' families, to hold less conformist values, and to 'over-achieve' in school work relatively to their IQ. But the generality of these findings is open to some doubt, both because of the atypicality of the group studied and because within this special group only contrasting and extreme minorities were studied in detail, and the majority of the children whose performance was not so fully described were neither exceptionally 'creative' nor exceptionally 'intelligent' but scored more or less equally on both sets of tests.

Getzels and Jackson reported correlations between their tests of creativity and also correlations of these tests with IQ Such correlations, when compared, provide crucial evidence as to whether creativity and intelligence can justifiably be considered distinct traits. The evidence in this case was inconclusive. Correlations between tests of creativity were somewhat, but not very markedly, higher than the correlations with IQ. Further examination and analysis by other writers (e.g. Burt 1962, Marsh 1964) led them to conclude that no convincing separation of creativity from intelligence had been demonstrated. In considering these results one must bear in mind the technical point that, in a selected group, correlations will, other things being equal, tend to be lower than in a group covering the whole range of ability. If the range of variation is restricted on both variables that are being correlated, this effect will be particularly marked. One would therefore expect low correlations between different kinds of ability in a sample like that chosen by Getzels and Jackson. On the other hand, the comparison of correlations between creativity tests with intelligence/creativity correlations will probably not have been greatly affected, since both kinds will have been attenuated by restriction of range, probably to about the same extent.

Rather similar work to that of Getzels and Jackson has been done by Hudson in England. As in the American research, it appears that the groups of Public and Grammar school boys tested were of above-average ability. Hudson adopted the same procedure of forming contrasting groups. These he described as 'divergers' and 'convergers', claiming very reasonably that this distinction begs less questions than that between 'creative' and 'intelligent'. Hudson, like Getzels and Jackson, investigated the differing characteristics of the two groups. He found that the differences went beyond cognitive style and seemed to reflect deep variations in personality including differences in type of ego-defence mechanism adopted.

Another important finding was of a marked relation between, on the one hand, divergent thinking and specialisation in arts subjects and, on the other, convergent thinking and choice of science subjects. This is a new result rarely found in the extensive American research in this field. It is not clear which is cause and which is effect; very possibly the high degree of early specialisation in English selective secondary schools contributes to the relationship. Cameron (1967) inclines to this view. Her research, which was to a large extent a test of Hudson's hypothesis, but with Scottish undergraduates in place of English schoolboys, partially confirmed the association between cognitive style and subject choice, but the lower degree of relationship found in the less polarised Scottish educational system perhaps suggests that the relationship itself arises from the greater degree of specialisation in English secondary education.

Another Scottish research (Hasan and Butcher, 1966) produced results quite different from those of Getzels and Jackson and of Hudson. 175 children (100 boys, 75 girls) in their second year at an Edinburgh comprehensive secondary school were tested with a battery of creativity tests; other measures included Moray House verbal reasoning, English and arithmetic quotients, and teachers' ratings on 'desirability as a pupil'. The creativity battery included ten tests; four of these were the same as in the research of Getzels and Jackson, and the remaining six included Torrance's 'Circles' test and an adaptation of the Remote Associates Test constructed by Mednick (1962).

One finding in this research was that 'creativity' and 'intelligence' overlapped to such an extent as to be hardly distinguishable. The correlations were sometimes as high as those that would be obtained if tests of creativity alone were administered on more than one occasion. Where possible, direct comparisons were made with the results of Getzels and Jackson. In their report, the correlation between scores of boys on the 'Fables' test of creativity and IQ was +0 131. Hasan and Butcher found a correlation of +0.726. This discrepancy, because striking, requires comment on two counts. First, it is not due to the less selected group of children in the Scottish study, which might be expected to produce a higher correlation for the technical reason already described. Although the Scottish sample was more representative of the whole range of ability than the Chicago sample, the degree of variation was no greater. The higher correlation was not therefore, a statistical artifact. Second, a high correlation provides strong evidence of a relationship between two traits; a low one is not always good evidence of a lack of relationship. Many factors, and in particular the dubious reliability of new, experimental tests, can lower a correlation. The opposite does not apply; a high correlation is less open to alternative interpretations.

The difficulty of adequately separating creativity from intelligence among children of average ability by means of tests such as Guilford's was confirmed by other findings in this research. Besides the high correlations, more direct evidence was available. One of the aims of the experiment was to repeat several aspects of the Getzels and Jackson work, by dividing the children into two groups, one highly creative and relatively less intelligent, the other vice versa. Another aim was to extend the American research, which had been criticised for omitting any account of the children who were high on both creativity and intelligence. Hasan and Butcher therefore divided the Scottish children into four groups - high on intelligence, high on creativity, high on both and low on both. It was found, however, that scores on intelligence and on the aggregate of creativity tests overlapped to such an extent that it was virtually impossible to form a group very high on intelligence but relatively low on creativity. When such a group was formed, as nearly as the pattern of scores permitted, its mean IQ was lower than that of the 'high creativity and high intelligence' group. Owing, no doubt, to this very considerable overlap between creativity and intelligence in their sample of children, Hasan and Butcher found little confirmation of other findings by Getzels and Jackson. There was little indication that the more creative children were scholastic 'over-achievers' or that their abilities were relatively unappreciated by their teachers.

This failure to separate creativity from intelligence in a representative group of children has been paralleled in American studies. Edwards and Tyler (1965), studying children in a non-selective American junior high school, found almost entirely negative results and concluded that Getzels and Jackson's findings about the relation of creativity, intelligence and school achievement were not widely generalisable.

Wallach and Kogan (1965) reviewed a number of other American studies and after careful analysis and evaluation, concluded that in none of them had creativity been satisfactorily demonstrated to be a unitary trait distinct from intelligence. Their review is the more convincing in that they appear more technically competent than some of the earlier investigators, particularly in their handling of statistical techniques.

Wallach and Kogan confessed to disappointment with the earlier researches and advanced the hypothesis that lack of success in distinguishing creativity from intelligence might have been due to the conditions and atmosphere in which tests had been administered. This suggestion had also been made by Torrance, but not fully tested before the experiments of Wallach and Kogan. In their experiments they accordingly took care to ensure that all the psychological measures were obtained in situations designed to minimise 'test anxiety'. Their subjects were primary school children, and the 'experimenters' were teachers (already well known to the children) who, instead of using conventional testing procedures, obtained the required measures during 'games' and 'lessons' without upsetting the normal school programme or giving any clue to the children that they were being tested.

Wallach and Kogan found this procedure yielded interesting results. The tests used were measures of associative fluency in response to both verbal and non-verbal stimuli and were given untimed. The extent to which creativity could be assessed separately from intelligence by these procedures is shown by the following correlation coefficients. The average correlation between measures of creativity was just over +0.4, whereas the average correlation of these with intelligence was only about +0.1. The children were assigned to groups in the now familiar way; high/high and low/low groups were studied as well as those with markedly different scores on the intelligence and creativity measures. The four groups were compared in many ways, including attitude to school work, degree of social adjustment and level of anxiety. One finding was that, in the typical school atmosphere, the high creativity and low intelligence group were particularly unhappy. "These children are in conflict with themselves and with their school environment and are beset by feelings of unworthiness and inadequacy. In a stress-free context, however, they can blossom forth cognitively."

One more research in which an unselected group of children was extensively studied is reported by Cropley (1966). This is also one of the few studies in which a representative selection of tests both of intelligence and creativity have been factor analysed (except for the extensive series of researches of Guilford's laboratory, which, as already mentioned, are guided by a rather different theory). Six measures of 'convergent' thinking and seven of 'divergent' were employed, the latter including some devised by Guilford and by Torrance and also Mednick's Remote Associates Test. When the battery was analysed, five apparently significant factors were found, of which the first two, accounting for most of the variance, were identifiable as factors of convergent and of divergent thinking. When these were orthogonally rotated, it proved impossible to obtain a factor of divergent thinking that was not also characterised by high loadings of some convergent measures. This was more nearly possible when oblique rotation was employed, resulting in factors that correlated +0.51. Even then, however, the 'divergent' factor was still partly dependent on 'convergent' processes. Cropley concluded that "it would be wrong to argue either that convergent and divergent thinking cannot be distinguished from each other factorially, as some authors have suggested, or that they are completely independent of each other as has been suggested by others .... It is unacceptable to think of creativity as a separate basic intellective mode."

In another recent factorial study of convergent and divergent thinking, Lovell and Shields (1967) came to rather similar conclusions. Their sample consisted of fifty 8 to 10 year old pupils, all of whom had obtained a Wechsler Intelligence Scale for Children (WISC) verbal IQ of 140 or higher. In view of the research results already discussed, one would expect a clearer differentiation of divergent from convergent abilities among this gifted group than among an unselected group such as Cropley's. On the other hand, the number of subjects (50) in Lovell and Shield's study is rather small from the point of view of yielding reliable correlation coefficients and factorial structure. Six factors were extracted from the battery of seventeen cognitive variables, and orthogonally rotated. Lovell and Shields interpreted the results as follows: "the first dimension clearly indicates an ability measured by the WISC scales or g + v:ed ability; the second reflects a capacity to think logically in the Piaget type situation, while the remaining dimensions suggest that divergent thinking cannot be accounted for by one dimension; rather the able pupil is 'creative' to different degrees according to the task that is set him."

To summarise the researches so far reviewed, it seems clear that, in any group of people covering the usual range of ability, creativity as assessed by the Guilford-Torrance-Messick tests of divergent thinking overlaps very considerably with intelligence as assessed by conventional tests. Most of the studies in which the two traits have been clearly separable have been based on selected groups of high ability. The main exception to this general finding is the work of Wallach and Kogan, which urgently requires replication. Indeed, before many of the researches quoted had been carried out, several writers had advanced the hypothesis that creativity and intelligence become progressively more distinct as one moves up the scale of general ability (Meer and Stein, 1955; McClelland, 1958; Anderson, 1960; Mackinnon, 1962 and Barron, 1963). Two recent papers describe the testing of this hypothesis.

Yamamoto (1965) investigated two groups of American primary schools, one in a rich suburb of a large city in Minnesota, the other in a middle-sized industrial city in Ohio. The two samples numbered 461 and 827 respectively. Yamamoto made two corrections to the 'raw' correlation coefficients between creativity and intelligence, first to allow for restriction of range and second to allow for attenuation caused by unreliability of the creativity battery. In both samples the correlation between creativity and intelligence after the first correction was just below, and after the second correlation just above +0.5.

In addition, there was a consistent decrease in the size of correlation between creativity and intelligence as the intelligence level of sub-groups increased. Yamamoto concludes that "we should regard creativity tests as complementary components in new and more inclusive measures of human intellectual behaviour, and not as a measure wholly independent and exclusive of the general factor of intelligence".

Further confirmation of the hypothesis is provided by Haddon and Lytton (1968), who administered six measures of divergent thinking (five taken or adapted from those developed by Torrance in Minnesota) to children in four primary schools in S.W. England. The schools were selected to form contrasting groups, being respectively 'traditional' and 'progressive' (or 'formal' and 'informal') in methods and atmosphere. In both groups, the trend, described by Yamamoto, of decreasing correlation between creativity and intelligence with increasing level of I.Q. was found. In both kinds of school the correlations between creativity and I.Q. were higher when the latter was assessed by verbal tests, as one might have expected in view of the predominantly verbal nature of the Minnesota tests of divergent thinking. Haddon and Lytton also found confirmation of another hypothesis that their experiment was designed to test; scores in divergent thinking were relatively higher in the two 'informal' schools. These differences were significant also on the separate tests in five out of six cases. They were particularly marked in scores on the non-verbal tests such as Torrance's 'Circles' test. Haddon and Lytton accounted for this finding in terms of the specific handicap in verbal skills among many of the less able children (less able in 'convergent' thinking).

Creativity and Personality

It seems highly likely that differences in creativity are more related to non-cognitive than to cognitive traits. The evidence already reviewed has shown some of the limitations of the purely cognitive approach. Unfortunately, much less systematic work has been done in the more difficult and debatable field of personality study, particularly in this country. What little we know about the relation between creativity and personality is mainly due to American psychologists, particularly Roe, Mackinnon, Barron and Cattell.

Anne Roe (1951a, 1951b, 1953) was a pioneer in the detailed study of the personality traits of scientists (physicists, biologists and psychologists) who had made original or 'creative' contributions to their respective sciences. In these groups she found personality differences to be more crucial than differences in intelligence, and concluded that fairly high intelligence with a very high degree of persistence and motivation was more characteristic of the most eminent scientists than very high intelligence with rather less persistence. Another clear finding in her series of researches was the marked independence of mind and self-sufficiency of these scientists. Although not overtly dominant or bossy, they showed considerable stubborness and autonomy of judgment. From early youth, more of them than not "had pursued rather independent paths - playing with one or a few close friends, instead of a gang"

Further light on the relation between creativity and independence of group judgments is thrown by the research of Barron (1963). In chapter 14 of his book Creativity and Psychological Health, he describes experiments employing the techniques originated by Solomon Asch. In these experiments a subject is placed in the disturbing position of being confronted by a group of people ('stooges' of the experimenter, but not known by him to be so) who, in effect, swear black is white. His persuasibility or conformity to group pressures is thereby assessed. In such experiments it is common to find that about 75 per cent of subjects are substantially affected by such group pressures, but about 25 per cent cling firmly to their own opinions. Barron studied differences between 'independents' and 'yielders', particularly in respect of creativity and originality. The two groups differed quite markedly in their self-image as elicited by the Gough Adjective Check List. The self-description of the 'independents' typically involved a strongly positive valuation of originality and a spirit of open-mindedness, a high degree of emotional reactivity and excitability and a lack of social ease combined with an absence of commonly valued social virtues such as tact and prudence. The 'yielders', on the other hand, saw themselves as easy and helpful in interpersonal relations, patient, efficient, stable, modest and healthy-minded.

Barron also tested the hypothesis that 'independents' would be more likely than 'yielders' to be able to deal comfortably with complex and apparently contradictory phenomena, as suggested by their performance in the Asch 'conformity test'. This hypothesis was confirmed, to the extent that 'independents' showed a greater preference for complex figures and designs when tested with the Barron-Welsh Art Scale. 'Independents' were found to 'like some uncertainty' and not to 'respond favourably to polish and perfection'. They apparently preferred imperfections and contradictions that challenged the understanding and called for imaginative completion by the observer.

Little research on these lines appears to have been carried out in this country, with the exception of interesting, unpublished work by Marino in Edinburgh. His research is concerned with the relation between creativity and social conformity, with particular reference to different religious groups in different countries (e.g. catholics brought up in catholic schools in N. Ireland, U.S.A., Scotland; catholics educated in non-catholic schools in these countries, etc.). Marino (1967) has described his modified version of the Asch technique, but his findings are still not fully analysed. The modification in technique was twofold - first, instead of the individual being confronted by a number of 'stooges', a group test was substituted, with consequent great saving of testing time; second, this group test situation (in which subjects, without being aware of the fact, were presented with different data which they were asked to compare with a single, common criterion) avoided some of the rather unethical features of the Asch-type situation. Provisional findings from Marino's research suggest a strong relation between religious affiliation and both conformity and creativity. Catholics, and particularly those educated in Catholic schools were found in general to be less creative and more persuasible or conformist in each of four countries. These differences interacted considerably, however, with local or cultural differences, being large in Milwaukee, smaller in both Belfast and Dublin and negligible in Edinburgh. The ordering of these differences was unexpected and hard to explain.

Mackinnon (1962a, 1963b, 1965a, 1965b, 1967) has made considerable contributions to our limited knowledge of the relation of creativity to personality, although many of his papers are somewhat inaccessible. He is convinced that cognitive tests of divergent thinking such as those of Guilford and Torrance are not adequate to distinguish creative and non-creative people in terms of real-life achievement, and quotes studies such as that of Taylor et al (1961) in which such tests failed to discriminate between creative and less creative research scientists. MacKinnon sees more promise in the assessments of biographical, temperamental and motivational factors, and produces quite convincing evidence to this effect from his own researches. Of these, his best known and perhaps most impressive is a study of 124 American architects.

These consisted of three groups, rated and classified by eminent colleagues as representing clearly different levels of creative talent. They were extensively studied and tested with (among other measures) the Strong Vocational Interest Blank (Strong 1959); the Study of Values (Allport, Vernon and Lindzey, 1951); the Myers-Briggs Type Indicator, based on the Jungian theory of types (Myers, 1962); the California Psychological Inventory (Gough, 1957); and the Minnesota Multiphasic Personality Inventory (MMPI) (Hathaway and McKinley, 1945).

Findings were too extensive to summarise adequately here, but some of the more interesting were as follows. With the Strong inventory remarkable results were obtained when one considers that the sample was highly selected, in the sense of consisting of members of one very skilled profession. 40 of the 57 measures correlated significantly with the criterion of creativity. e.g. Artist +0.59, Author-Journalist +0.54, Policeman -0.52, Accountant -0 54, Banker -0.66. The multiple regression of scores on the three scales for Office worker, Banker, and President of manufacturing company (all with negative weights) was 0.80, and 0 55 when cross-validated.

Results with the Study of Values were hardly less interesting. Among MacKinnon's creative architects, 'aesthetic values' were highest, with 'theoretical values' almost as high. Rather similar results were found in other researches by MacKinnon using as subjects creative scientists and mathematicians. In all cases, these two kinds of value were conspicuously high relative to the other four assessed by the test (social, political, religious, economic); but among the scientists theoretical values were marginally higher than aesthetic, and among the mathematicians both were almost equally prized. MacKinnon comments on the incompatibility of these two kinds of value in the general population and the apparently exceptional ability of the creative person (whether in art or science) to tolerate the tension of strong opposing values (cf. the findings of Barron already discussed).

Striking results were also obtained with the Myers-Briggs test. One pair of contrasting styles assessed by this measure is between people who depend largely on sensation or sense perception and those who depend mainly on intuition. A preference for the latter is said to make one "alert to the links and bridges between what is present and that which is not yet thought of". In the general American population, 75 per cent are 'sensation' types. In contrast, in MacKinnon's creative groups the overall figure was 25 per cent, and in the sample of architects it was zero.

Among other characteristics of the creative architects revealed by the extensive testing programme were dominance, rather low sociability, freedom from conventional restraints and inhibitions, readiness to admit views that were unusual and unconventional, relatively high femininity of interests, and a general level of score slightly higher than the population average on those scales of the MMPI that measure tendencies to major neurotic or psychotic tendencies such as depression, schizophrenia, hysteria and so on.

These findings of MacKinnon are interesting and thoroughly based. They cry out for repetition (and for extension to other professional groups) in this country. It would also be useful to discover how far these traits are present among students preparing to enter such professions, and how far on the other hand they are developed by practice of the particular profession; also how far they discriminate between outstandingly able and relatively run-of-the-mill students. The work of R. B. Cattell (and of people using his personality measures) is equally suggestive, and, although based on different assumptions and techniques, is not incompatible.

Three studies involving the use of Cattell's 16 PF test produced quite consistent results, although the samples of subjects differed rather widely (Cattell and Drevdahl, 1955; Drevdahl, 1956; Drevdahl and Cattell, 1958). In Drevdahl's research, the subjects were graduate or advanced undergraduate students from arts and science departments in the University of Nebraska. Two raters each made two ratings of the originality and creativity of the students; the ratings were found to be adequately reliable. Significant differences between groups of students rated as creative or relatively non-creative were found on four of the sixteen personality factors; in each case the difference was equivalent to a biserial correlation of between 0.3 and 0.5. Creative students scored higher on radicalism (Q_1) and on self-sufficiency or independence of judgment (Q_2) and lower on cyclothymia (A) and surgency (F). These differences are in line with the findings (already described) obtained by investigators with quite different theoretical attitudes, and have been confirmed in other investigations employing Cattell's tests.

Cattell and Drevdahl (1955) studied 140 eminent research scientists, about equally divided among physicists, biologists and psychologists, and compared their personality profiles with those both of the general population and with those of people of equal eminence whose talents were for teaching or administration rather than for research. Interesting similarities and differences were found between the group of creative research scientists and the control group of teacher/administrators. Both scored well above the population average in ego-strength, intelligence, dominance and strength of self-sentiment. The differences paralleled those found by Drevdahl among students in the research already described. The creative researchers were characterised by high radicalism (Q_1) and self-sufficiency (Q_2), also by low surgency (F) and low cyclothymia (A). In addition they scored significantly lower than the administrators on ego-strength (C) and significantly higher on bohemianism (M). In terms of second-order personality factors it is clear that the researcher is uniformly lower on almost all the elements of extraversion.

The third of these studies (Drevdahl and Cattell, 1958) was concerned with the personality profile of creative artists and writers. Again rather similar or at least compatible, results were obtained. On the four factors characteristic of creativity in the two earlier studies (A -, F -, Q_1 +, Q_2 +) they differed significantly and in the same direction from the norms of the general population. In addition, they were found to score higher on the average, on dominance (E), emotional sensitivity (I), bohemianism (M) and ergic tension (Q_4). The last three factors seem particularly characteristic of artistic as distinct from scientific creativity.

The only British study of this kind (Cross, Cattell and Butcher, 1967) provides further confirmation of these findings. Sixty-three artists (36 male, 26 female) were selected as having given clear evidence of unusual talent in drawing and painting. All were rated by competent judges as capable of making a professional career as artists. Sixty-three subjects in a control group were chosen as having never practised painting even as a hobby. Of the eight factors described in the previous paragraph as distinguishing (in the Drevdahl and Cattell research) between creative writers and the general population, significant differences were found between the two British groups on seven in the same direction. In addition, significant differences were found on four other personality factors. A particularly interesting finding in this research was that on eleven of these twelve factors a group of craftsmen (potters, silversmiths, dress designers and so on) obtained intermediate scores between those of the artists and controls.

Rather similar results have been obtained in other researches. Chambers (1964) found creative scientists to score more highly than the general population on self-sufficiency (Q_2) and lower on surgency (F). Tollesfson (1961), studying productive research chemists working for an American oil company again found high radicalism (Q_1) and intellectual self-sufficiency (Q_2) predictive of successful research performance. A more extensive review of this whole field is provided by Cattell and Butcher (1968).

It is surprising that little research has been carried out in this field by using Eysenck's measures of introversion-extroversion and neuroticism-stability. Unpublished work by Di Scipio (at the Maudsley Hospital) that is now almost complete will help to fill this gap.

To sum up this work relating creativity to personality traits as assessed by questionnaires and similar measures, much of it is tentative and requires confirmation, but the approach is promising and many of the results suggestive and reasonably consistent.

Chapter 3. SPECIAL ABILITIES IN CREATIVITY: THE STRUCTURE OF THE INTELLECT

The work of Professor J. P. Guilford and the Aptitudes Research Project at the University of Southern California is perhaps best understood within the framework of the general concept of intelligence. Guilford's work has been developed in a theoretical background which involves the conception of a congeries of primary abilities which are related to each other in multiple second order factors defining wider ranging abilities of greater generality. The second order, or 'group factors' themselves demand investigation in the form of experimental enquiry and the construction of appropriate psychological tests the initiation of which, as discussed more fully below, have stimulated important contemporary research into creativity. This incorporative theory of the mind is expressed in the 'structure of intellect' model, a succinct statement of which is given in Guilford's well-known paper 'Three faces of intellect' (1959).

In one important respect Guilford's theory derives from a whole body of critical work, some of which was carried out by himself, stimulated by Charles Spearman's (1904) speculative conception of general intelligence which was later to be qualified and elaborated. Spearman's theory raised what have come to be central problems in the study of intelligence and ability: the existence of general intelligence; the existence of special as opposed to general traits; the existence of multiple group factors.

These issues have led to a great deal of experimental research in which the development of statistical expertise has fostered the analysis of 'multiple intellectual factors'. Notable contributors to these enquiries were Spearman himself, Burt (1927), Thomson (1939), Vernon (1950) and Thurstone (1938). This research gave rise to parallel considerations in the field of practical education and in the use and development of psychological tests and test batteries. The notion of g as a factor of general intelligence offered some considerable attractiveness to early educational practitioners as a support to the practical idea of using a single numerical score as an index of general intelligence. The development of psychological test construction, often initiated by Spearman, Burt, Vernon, Guilford and others involved in multiple factor analysis, and in the construction and use of psychological tests, however, gave evidence of the existence of low correlations between individual scores on different tests. This stimulated research into the investigation of multiple intellectual factors and involved a theoretical re-examination and development of the concept of g as a general intellectual factor.

Guilford's theory of intelligence, based on the existence of multiple 'group' factors assumes that there are special intellectual abilities which, taken collectively, may be regarded as forming intelligence. Guilford typifies these as "a commonwealth rather than a nation".

At this point it must be stressed that general theories of multiple intellectual factors differ in important respects. Notable cases in point here are the theories of Vernon (1950) and Burt (1949) and in contrast, those of Thurstone (1947) and Guilford (1959): the former being typical of what may be called the British view, the latter being typical of the American view. Professor Stephen Wiseman (1967), in his recently published collection of readings Intelligence and ability, draws attention to this distinction and outlines some important differences most effectively. To quote: "The British tend to see the structure of the mind as an hierarchy: general ability, g, subsumed by many group factors, each of which may be broken down into smaller elements. Thurstone and other American writers, on the other hand, conceive of the mind as consisting of a miscellaneous assortment of primary abilities. These, however, are themselves related to each other, and by the technique of 'second-order factors' more pervasive and wide-ranging abilities may be postulated. Both views, in the end, reach the concept of an hierarchical structure, and the end products of the two opposing schools bear strong resemblances. No doubt before long further research will bring the emergence of a rapprochement." These considerations raise some important observations in relation to creativity research.

The distinctions discussed by Professor Wiseman form the basis of continuing and full-time investigation. Much of this is likely to be initiated and augmented by developments in the research into creativity, a factor which illuminates the importance of creativity as an integral concept in psychology and education. This line of thinking is developed in various contexts below. Our more immediate purpose in this monograph, however, is to describe Guilford's contribution to 'creativity' and although we can most effectively do this by giving an outline of his general theory this must remain a subsidiary element. The evaluation of Guilford's theoretical position involves thorough and specialist analysis the scope of which is related to but outside our immediate task.

In line with our standpoint in this monograph our policy is that of indicating and describing research areas of particular importance and interest rather than attempting to make a conclusive report - inevitable in a field which is so inter-connected with the major areas of general psychological enquiry. Research workers wishing to pursue these questions further are recommended to follow the lines suggested in Professor Wiseman's selection of readings, a scholarly work which presents some unique specialist contributions in one volume and suggests some avenues for further enquiry.

Guilford's work in the Aptitudes Research Project is perhaps best seen as a development of the work carried out by research psychologists in the U.S. Army and Air Forces during World War II c.f. Guilford and Lacey (1947). Theoretical developments are related to the extension of the fields of investigation and enquiry stimulated by the massive selection and assessment problems of war-time mobilization. The investigation of e.g. memory abilities and, particularly in the cases of high-level personnel, planning and leadership abilities are cases in point. The Aptitude Project, an extension and continuation of the war-time research, carried its investigations into the areas of creative thinking and problem solving. Guilford and his co-workers developed tests of great variety seeking to establish the existence of special and new kinds of abilities which were not measured by traditional tests of intelligence.

In order to create a suitable climate in which to investigate new kinds of abilities Guilford developed a comprehensive theoretical system, or model, incorporating the known intellectual factors and also predicting additional factors not previously demonstrated. This system or model is known as the structure of intellect model (Guilford, 1959). It was developed out of attempts to classify the more or less established intellectual factors of which there were approximately forty. Each factorial ability was identified in terms of the set of tests that measured it in common, the kind of information involved, and the kind of operation that the subject had to perform in doing the test. Guilford points out that a test could be based upon visual forms, or numbers, or meaningful objects; it may have involved relationships or classes; and the subjects may have been required to understand or remember, and so on

Abilities were classified in three different ways: a difference between the visual forms, numbers, and meaningful objects involved was classified as a difference in 'content'; that between relations and classes (and other such mental structures) was classified as a difference in 'product', while differences between processes, such as understanding (cognition) and memory, were classified as differences of 'operation'.

Experimental research and analysis suggested that there were four kinds of content, six kinds of product, and five kinds of operation. These combine one kind of content with one kind of product and one kind of operation to yield a total of 120 unique outcomes, each a potential intellectual ability, distinct from other abilities. Using the structure of intellect model to generate hypotheses regarding unique intellectual abilities, and with tests constructed for each one in turn, Guilford and his co-workers have so far demonstrated approximately 70 intellectual factors.

The structure of the intellect model, therefore, is designed to articulate the range of human abilities including those involved in creative endeavour. Of particular importance, in this connection, are the 'divergent' - production abilities in general, which serve to determine the fluent generation and development of ideas. 'Divergent Production' is essentially one of five categories of 'operation' mentioned above in our outline of the structure of intellect model - the others are: cognition, memory, convergent production and evaluation. Divergent production means the generation of diverse ideas about given information. It may be usefully contrasted with the 'convergent production' abilities. In convergent production there is only one right answer, which is fully determined by the information given.

In the case of divergent production Guilford suggests that we are looking for logical possibilities while in the case of convergent production we are generating logical necessities. Guilford goes on to point out that while there are characteristic differences between the kinds of problem-solving situations which ordinarily stimulate divergent and convergent production, creative thinking usually involves the combined use of both kinds of activities. This is a most important suggestion which has stimulated a good deal of valuable research. Creativity, effective thinking and the solution of difficult problems usually involve the sequential use of convergent and divergent thinking. Some of the contemporary research based on this premise is discussed below.

In order to explain the use of these terms more fully it is perhaps advisable to discuss the 'structure of intellect' model in somewhat greater detail. We have seen that 'convergent' and 'divergent' production are classified as basic operations. These combine with four kinds of content and six kinds of product to give a number of abilities. The distinctions in content are defined as figural, symbolic, semantic and behavioural, and the distinctions in product are defined as units, classes, relations, systems, transformations and implications.

In this structure of intellect model each ability usually involves an operation, a class, and a product. In the case of 'divergent production' or 'divergent thinking', which is an operation variable, there will be a class and a product. We may therefore take, for example, the divergent production of semantic classes. In order to assess this ability Guilford has designed a test of creativity known as the Multiple Grouping Test. In the divergent production of a given semantic class the subject is required to produce as many different classes as he can out of a short list of meaningful words. One item from the Multiple Grouping Test presents a list of words: arrow, bee, crocodile, fish, kite, sailboat and sparrow, from which the classes of animals, things that go up in the air, things that go in water, or living things may be produced. The testee must construct and derive such classes and re-allocate the items in different ways.

A further illustration of divergent-production ability is that involved in the Ideational Fluency Test. This is one of the tests which involves what Guilford has called the divergent-production of semantic units. In the structure of intellect model units are described as being composed of information such as perceived objects, syllables or verbal meanings. In the Ideational Fluency Test the subject is given a number of tasks which involve listing objects which will fulfil certain functions and have certain properties e.g., that are both fluid and will burn, and is allowed a limited amount of time in which to carry out the exercise. In another test - the Unusual Uses Test the subject is required to list as many possible uses he can think of for a brick - however bizarre his answers may be.

An example of divergent production of semantic classes has already been given in Multiple Grouping tests. For the case of relations, the test Associational Fluency is used. In such a test the subject may be asked to list all the words he can think of that mean about the same as the word to "fly". The relation is similarity. He might give such responses as: to soar, to travel, to take wing, to sail, to speed, or to levitate.

Systems are organised constructs of more than minimal complexity, such as two things in a simple relationship. A test for divergent production of semantic systems is Expressional Fluency, requiring the construction of a variety of four-word sentences, a sentence being a kind of system.

Guilford suggests that a most interesting and surprising kind of product is the transformation. A transformation is any kind of change, revision or redefinition. In a test called Plot Titles, the subject is given a short story and required to suggest a variety of clever and interesting titles. As he generates a different, clever title, he must take a new look at the story, seeing it in a somewhat different light. The result is often in the form of a pun or an unusual allusion to something well-known but revised somewhat to suit the purpose. To take the fable about the fox and the grapes, for example, the title might be "The Fox Griped about Grapes", or "The Fox's Grapes of Wrath". Guilford also suggests that the abilities concerned with transformations are undoubtedly contributory to flexibility in thinking and problem solving, and hence should be important in creative production, along with the divergent-production abilities in general, which also serve to make thinkers fluent in the generation of ideas.

Implications are expectations or anticipations. When one item of information suggests another, there is an implication. Guilford submits that an implication comes as close as any of the kinds of products to the concept of 'association'. It is argued that this concept has been used, unwarrantedly, to refer to several different variables. In the structure-of-intellect theory it is proposed that the six kinds of products should be substituted for the single concept of 'association'.

Guilford goes on to suggest that: "In the area of cognition, abilities to see implications play roles in activities like planning and they should be basic to foresight and to hypothesis formation. To test for divergent production of semantic implications, a test like Possible Jobs may be given. Each item presents a stylised, familiar object as a kind of symbol; for example, a picture of an electric light bulb, where the subject has to say what jobs or groups of people it might stand for. Here the answers might be: electrical engineer; missionary; teacher; scientist, and so on."

It is suggested that in everyday life, such abilities as those mentioned above (they are also regarded as intellectual functions) rarely play their roles in isolation. Guilford suggests that the major kind of information may be fairly limited to that which is perceived (figural) but two or more might well be involved simultaneously, as different aspects of the same thing, and much translating goes on from one category to another. In learning mathematics, for example, a new mathematical principle or operation is verbalised (semantic), the idea is illustrated graphically (figural), and the equation is solved by operating with numbers and letters (symbolic). Different learners may well acquire new information better in one of these 'languages' than in others. Guilford suggests, therefore, that teaching in all three languages should be more effective and reach more individuals than is done when teaching in one, or even two.

Guilford argues that the factors of intelligence are neither completely general nor are they very specific in scope. To quote: "They can be conceived as generalised and generalisable skills, each with certain limitations, but each playing roles in its own area, as witness the fact that any one test for a factor is made up of a list of specific items, all different, from a potentially very large pool, and also the fact that there can be some variation in kinds of items that also involve the factor."

Attention is drawn to an article by G. A. Ferguson (1954) which puts forward the theory that a factor ability is itself formed through a process of transfer. It represents an area of mental functioning within which transfers occur naturally. Guilford points out, however, that on the other hand, there is accumulating evidence that practice on tasks, within the area of a factor, is followed by measurable increase in performance in other tasks for that factor, for example in some of the factors of divergent production (Parnes and Meadow, 1959; Meadow and Parnes, 1959; Nicholson, 1959; Parnes, 1962).

This brings us to the general problem of interfactor transfers. Melametsa (1965) found transfer between tasks for the same factor that did not extend to two other factors. Guilford considers that it might be fruitful to determine whether inter-factor transfers do occur and proposes as a hypothesis that if such transfers do happen, they are more likely to occur between neighbouring factors in the structure-of-intellect model.

After conducting research into 'learning theory' considerations Guilford raises questions as to the implications of his findings, on multiple-factor abilities, for the traditional types of intelligence tests. He suggests that while these tests should not be completely replaced there should be numerous modifications and extensions. Guilford submits that tests of divergent-production abilities make substantial unique additional contributions to predicting academic performance (Getzels and Jackson, 1962; Cline, et al., 1962; Yamamoto, 1964). He submits that in the Aptitudes Research Project (Peterson, et al., 1964) it was found that tests of a number of factors not found in standard aptitude batteries contributed uniquely to predicting achievement in ninth-grade mathematics. This argument is supported by current research being carried out at the School of Architecture, University of Manchester. The following chapter describes and discusses this work in some detail.

Guilford's structure of intellect model is best evaluated at two distinct levels. The first is its importance as a general theory of multiple intellectual factors - a description of the structure of the human mind. As we indicated at the beginning of this chapter this task must be postponed as constituting a central problem in general psychology. The second level - that of its value as providing research hypotheses and ideas for test construction - is the one which must concern us here.

The Research Value of Guilford's structure of intellect model as a source for test construction and development has undoubtedly been enormous. The conception of divergent-abilities is a key concept in the work of Getzels and Jackson (1962), Cline et al. (1962), Yamamoto (1964) and in a considerable number of related enquiries. While other writers have introduced similar concepts to that of 'divergent production' none have used them so effectively as instruments with which to construct tests or criticise existing 'traditional' intelligence tests. There is also in 'the literature' considerable experimental investigation of concepts which closely resemble Guilford's 'divergent-production'. Colvin (1902) introduced a distinction between 'logical power' (organizational ability) and 'spontaneity' (imaginative ability) in his study of 'inventiveness' in the English essay-writing of schoolchildren, a study which he repeated in 1906. The work of Chassel (1916), Simpson (1922), Andrews (1930), Welch (1946), gives examples of experimental investigations which directly compare performance on tests of 'imagination' and 'originality' with traditional intelligence tests. As we suggested above, however, while these investigations reported findings similar to those of Guilford, none were so effective in terms of the attention they attracted.

On the theoretical side various terms have been used to describe the process variables described by Guilford as 'convergent' and 'divergent production'. Rogers (1959) uses the concepts of 'defensiveness' and 'openness'; Maslow uses the concepts of 'safety' and 'growth' to describe processes which are ostensibly similar to those of 'convergent' and 'divergent production'. Rogers' concepts however, are couched in a psychological theory known as 'the phenomenological field' approach, or the 'frame of reference' approach, a position which entails some quite serious philosophical and semantic difficulties. Maslow's concepts, on the other hand, while they are vital and important, are developed in the context of motivational theory. They lack, perhaps, the theoretical attractiveness and rigour of concepts based in a well developed factor-analytic study. In consequence it is difficult to make them consonant with related studies of intelligence. This, of course, is not to deny their importance and validity. It is to explain the relevant theoretical difficulties.

Guilford's own Test Batteries have been criticized by some writers on practical grounds, one good example of which is probably that of MacKinnon (1967) whose general contribution was discussed more fully in chapter 2 above. To quote: "In an intensive study of research scientists in the U. S. Air Force (Taylor, Smith, Ghiselin and Ellison, 1961), Guilford's tests of creativity failed to predict the criterion. In our own studies, these same tests likewise have shown essentially a zero correlation with the criterion. In view of such negative findings, the use of Guilford's battery of tests of creativity potential would be questionable, to say the least."

"It is not that tests of this sort fail to tap the kind of psychological processes involved in creative thought, requiring, as they do, that the subject think of unusual uses for common objects or the consequences of unusual events. It is rather that they fail to reveal the extent to which a person faced with a real life problem is likely to come up with solutions that are novel and adaptive and which he will be motivated to apply in all of their ramifications. Much more promising as self-report predictors of future creative performance are autobiographical questions concerning past and present manifest activities, competencies, and achievements, as are found, for example, in the American College Testing Program."

However, we have now reached a stage in our review where it is important to point out that the approaches of MacKinnon and Guilford are not mutually exclusive. They are, in fact, complementary. Tests of the type constructed by Guilford could be developed in the context of particular academic and professional disciplines and vocations. The results obtained from the use of such tests could be correlated with an external criterion and also with measures of the type described by MacKinnon e.g. the American College Testing Program. This constitutes an important avenue for further investigation. To illustrate this argument the following chapter describes work involving a test which has been designed to enable the relative effects of Guilford's 'divergent-convergent' tendencies to be seen in the assessment of creative aptitude in architecture. Positive results were obtained when the test was administered to architect-students.

In this connection it should be stressed that this work has been selected as a paradigm example from the point of view of expedition and convenience only. Research workers in other fields e.g. literature, art, science are recommended to initiate similar parallel enquiries. The descriptions of some of Guilford's tests as given above inevitably brief and cursory as they are, may be insufficient to give research workers ideas for test construction and development in their own fields. The research described in the following chapter has been carried out in the context of higher education and as it is discussed in some detail it should provide a fairly substantial basis for stimulating ideas for further test construction. A list of some of the publications of the Aptitudes Research Project is given in the selected bibliography at the end of the monograph.

Chapter 4. SPECIAL ABILITIES IN CREATIVITY : SOME RESEARCH INTO 'DIVERGENT' AND 'CONVERGENT' THINKING

In this chapter an example is given of some specific research, in the assessment of creative aptitude in Architecture, based on ideas derived from Guilford's conception of 'convergent' and 'divergent' thinking outlined in the previous chapter. The research discussed is essentially a development of earlier pilot research (Buttle, Freeman and M'Comisky, 1955). It has been reported in several journals (M'Comisky and Freeman, 1967; Freeman et al., 1968). It is hoped that the technique adopted will stimulate research workers in allied and other fields to initiate similar enquiries. The approach is based on the use of a psychological test which was hypothesized to make some of the same intellectual demands as those in such 'core' architectural subjects as Design and Construction. As will be described later in the chapter, the ability involved in the test may also have elements in common with education in a number of other subjects including, in particular, electrical and mechanical engineering.

In this connection, 'convergent' and 'divergent' thinking have special importance. While the operational use of these terms is discussed more fully in the text below, attention should be drawn to Guilford's original hypothesis that although there are characteristic differences between 'divergent' and 'convergent' thinking, or 'production', with respect to the kind of problem situations that ordinarily initiate the two kinds of activity, effective thinking frequently involves the ability to engage in both types of activity. In the discussion below this is examined and explained in more detail in the context of this research and with special reference to electrical engineering.

INTRODUCTION TO THE TEST

There are two crucial requirements in the measurement of ability by the use of psychological tests. The first is that the test should differentiate between people who have received education in connection with the particular ability, for example architecture, and those who have not. If the test is tapping the ability involved, then the general score-level of those who have studied architecture should be higher than those who have not. The second crucial requirement is that the test, or some other test, should differentiate between those who are likely to do well on a course where the particular ability is taught - architecture again, for instance - and those who are less likely to do well. The second requirement is thus in terms of prediction of ability rather than, as in the case of the first, measurement of developed ability.

In the present chapter we are concerned mainly with the first of these requirements: measurement of the ability involved in architecture. Work is in hand to extend the investigation to the second - the prediction aspect - and the results will be reported in a separate paper.

The test used in the present investigation was 'Abstract-Concrete (Performance) Test 1' devised by Mr. J.G. M'Comisky (1961) of Hull University. In this the testee is required to derive and manipulate dimensional and other concepts with which architects are particularly involved, e.g. size, height, shape, solidity, etc..

Theoretically A-C (Performance) Test 1 is based on a broader conception of the nature of intellectual ability found in the work of Guilford (1950; 1954) in the United States, as outlined in the previous chapter, and Hudson (1956; 1958) in this country. From this point of view effective thinking is regarded as having two complementary characteristics: first, the capacity to range flexibly, or 'diverge', in the search for relevant factors in connection with the particular matter in hand and, second, the capacity to focus or 'converge' in one's thinking on whatever factors have been decided upon as relevant. The A-C (Performance) Test 1 has been constructed so that in two parts of the test the emphasis is on the 'divergent' aspect of thinking, while in the two remaining parts the emphasis is on the 'convergent' aspect. The combined score for the four parts of the test thus gives a measure of the testee's overall ability to think effectively. The test and the administration procedure are described more fully below.

In line with our first crucial requirements in the measurement of ability, i.e. finding a test which will differentiate between people who have received education in connection with the particular ability and those who have not, A-C (Performance) Test 1 was administered to a group of 2nd year Architect students and to two groups of non-Architect 2nd year students: Economics undergraduates and Social Science undergraduates at the same university. There were twenty male students in each of the three groups. All were approximately the same age (20-22 years), the same intelligence level (Raven's Matrices) and the same secondary education levels (GCE results). Superior performance on the test by the Architect students as a whole would suggest that ability on the test was related to that involved in Architecture. Also, if it were found that the test distinguished within the group of Architect students between those who were considered to be doing particularly well by normal methods of assessment on the main part of the course and those who were doing poorly, this would take differentiation a stage further. It would also increase the likelihood of its practical usefulness, for instance, in the selection of Architect students.

ADMINISTERING AND SCORING THE TEST

As can be seen from Figure 1, A-C (Performance) Test 1 consists of sixteen blocks which differ in regard to ten characteristics. Some of the characteristics are related, e.g. size, height. Others are unrelated, e.g. shape, colour. As already described, the test consists of four parts. In two parts the demand on the testee is primarily in terms of 'divergent' thinking. In the first of these, the testee is required to arrange the sixteen blocks into two groups of eight blocks each in four different ways, the particular principle on which he does this being in each instance chosen by himself. A two-group sorting in terms of size is shown in Figure 2. In the second, the testee is required to sort the blocks into four groups of four blocks each in three different ways, the particular principles on which he does this again being chosen by himself. An example of a four-group sorting in terms of shape-size is given in Figure 3. This second

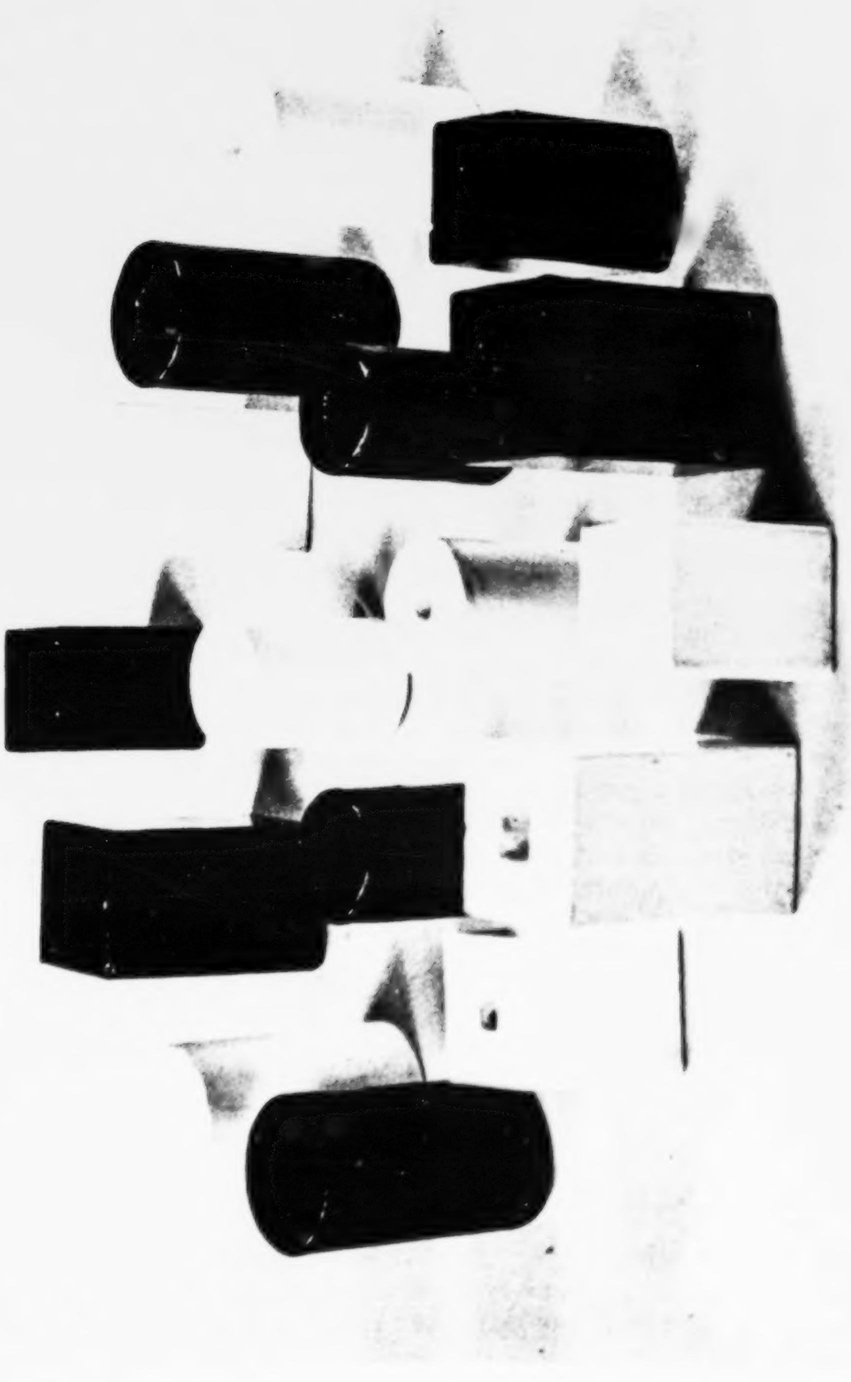

Figure 1. The A-C (Performance) Test.

(Note: The sixteen blocks are presented to the testee in random order, as shown above.)

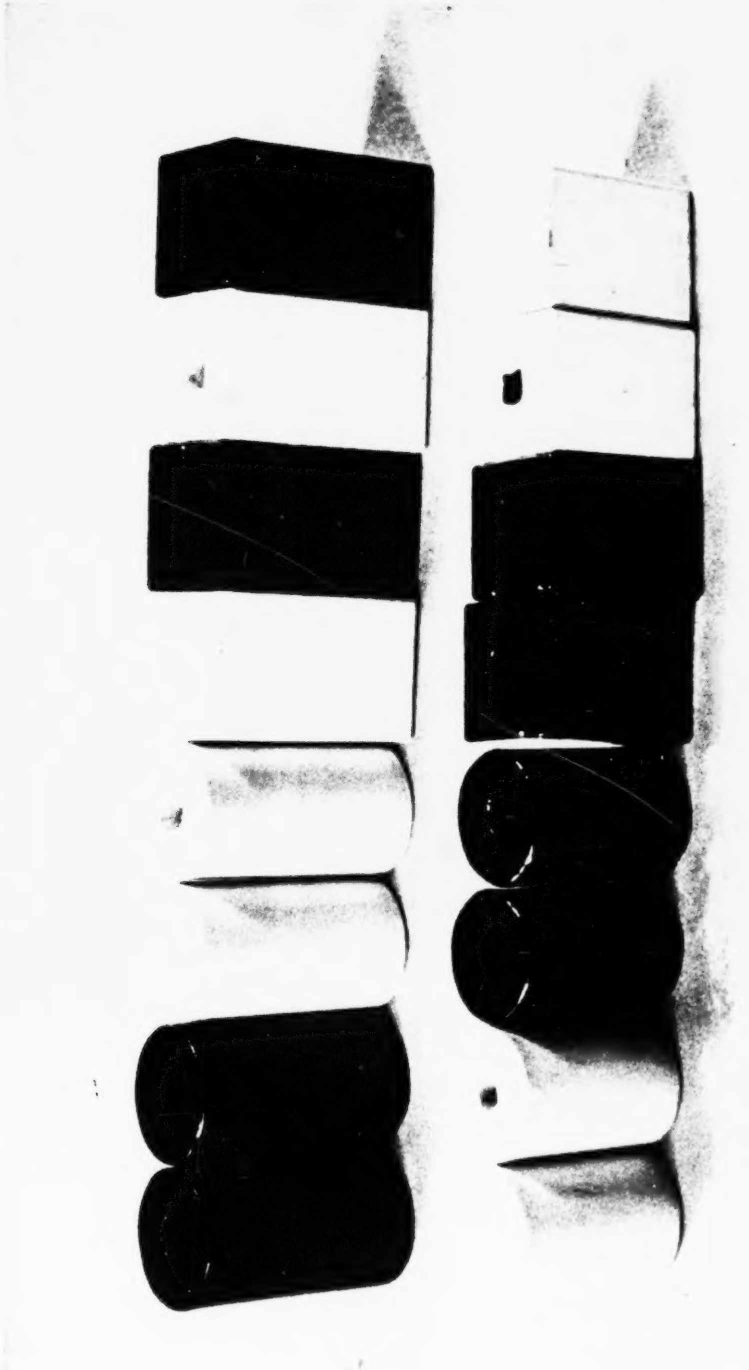

Figure 2. A two-group sorting in terms of SIZE.

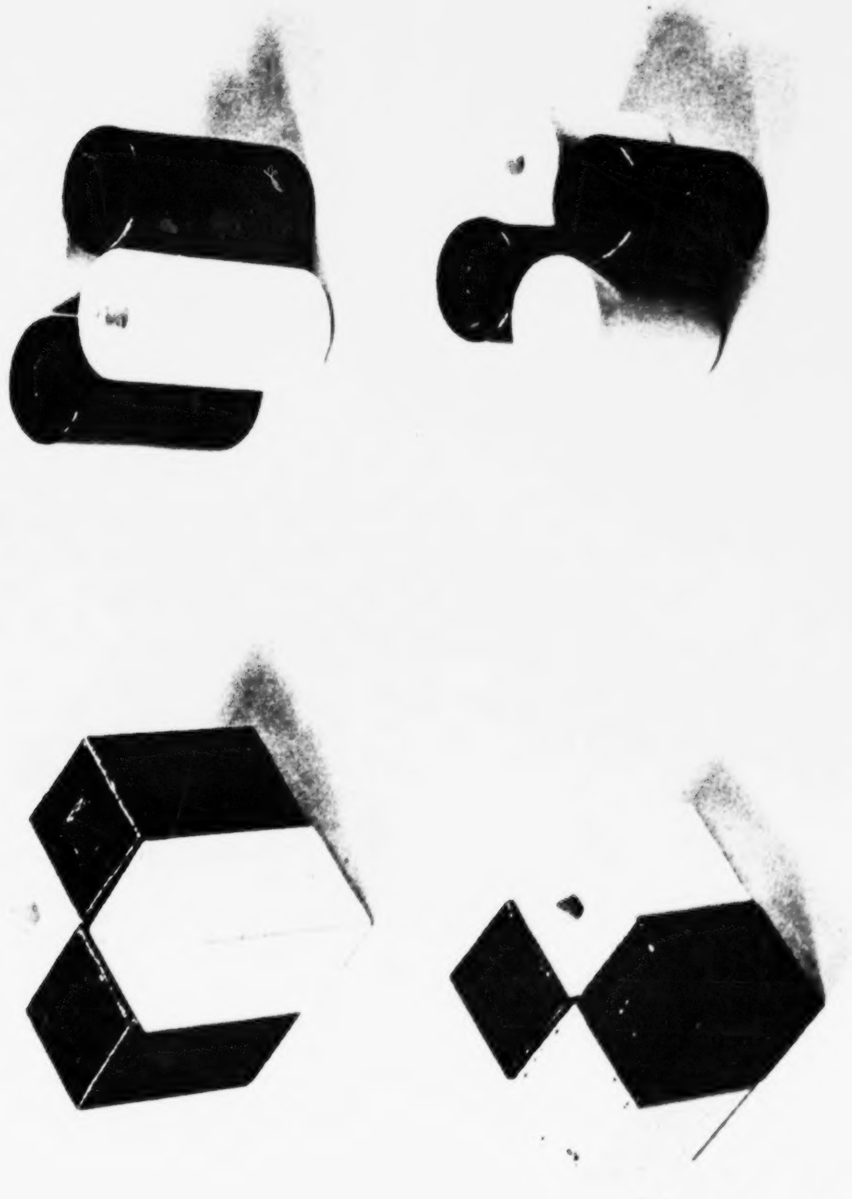

Figure 3. A four-group sorting in terms of SHAPE-SIZE.

'divergent' series is the most difficult part of the test. In the remaining two parts of the test the demand on the testee is in terms of 'convergent' thinking. In the first of these the testee again arranges the blocks into two groups of eight blocks each, but in the six instances in which he is required to do this he is told what principles he must use. In the second part, the testee is once more required to arrange the blocks in four groups of four blocks each but, as in the part just described, he is told the principles he must use. Nine different sortings are required for this final part of the test. Throughout these last two parts the main demand on the testee is that he should focus, i.e., 'converge' his thinking on the particular sorting principle he has been told to use, and exclude consideration of the irrelevant characteristics of the blocks while doing this. This demand is in contrast with that in the first two parts where the testee has to range or 'diverge' in his thinking while deciding what particular principle he should use for his sorting. Taken together, the two sets of scores for the 'divergent' and 'convergent' parts of the test give an indication of the 'balance' in the testee's thought processes.

The four parts of the test are scored for accuracy i.e., the testee's ability to carry out the required sortings, and for time taken in carrying out the sortings. The total accuracy score is obtained by combining the accuracy scores for the four parts of the test. Similarly, total time taken is obtained by adding the time (in seconds) spent in sorting the blocks in all four parts of the test.

RESULTS

The results are given in Tables 1 and 2. Table 1 shows the difference in the accuracy scores and time taken for the three groups of Architect, Economics and Social Science students. Table 2 gives the combined accuracy scores on the two 'divergent' thinking parts of the test for the six best and the six poorest architect students in terms of academic results obtained in the following four sessional course subjects:

Architectural Design: Practical work produced during the session - assessed at interim procedural stages, and as a final product.

Architectural Construction: Practical work, largely an extension of the constructional aspect of Design.

Building Construction: A three-hour examination paper of a practical nature.

Supplementary: Normally vacational work, embracing the measuring and sketching of existing buildings, and model making. The latter chiefly in the context of Architectural Design as described above.

Electrical and mechanical engineers will see some parallels in their work with these basic subjects in Architecture, for instance, in regard to the construction of power-stations and the design of transmission and distribution systems.

TABLE 1: Average scores, A-C(Performance) Test 1

Student Groups	Average Accuracy Scores			Average Time Taken in Seconds		
	All four parts of the test	Parts 1a and 2a ('divergent' thinking)	Parts 1b and 2b ('convergent' thinking)	All four parts of the test	Parts 1a and 2a ('divergent' thinking)	Parts 1b and 2b ('convergent' thinking)
Architect Students	54	26	28	398	212	186
Economics Students	44	20	24	600	280	320
Social Science Students	42	21	21	595	286	309

Notes:

1. **The superiority of the architect students is statistically significant (0. 01 level) for both accuracy and time taken.**

2. **The superiority of the architect students on parts 1a and 2a of the test combined ('divergent' thinking) is statistically significant (0. 01 level) for both accuracy and time taken.**

3. **The superiority of the architect students on parts 1b and 2b of the test combined ('convergent' thinking) is statistically significant (0. 01 level) for both accuracy and time taken.**

4. **The test score differences between economics and social science students are not statistically significant.**

(Stats. test: Median test, cf. Siegel (1956) in all cases.)

TABLE 2: Accuracy scores ('divergent' thinking) for the six best and the six poorest students in four Architecture subjects Examinations

Total accuracy scores ('divergent' thinking)	Total marks Architecture examination	Students and Architecture examinations	Number of students with accuracy scores exceeding 27	Number of students with accuracy scores not exceeding 27
194	380	BEST 6 students Architectural Design	6	0
152	280	POOREST 6 students Architectural Design	2	4
190	335	BEST 6 students Architectural Construction	6	0
157	246	POOREST 6 students Architectural Construction	2	4
187	374	BEST 6 students Building Construction	6	0
155	250	POOREST 6 students Building Construction	2	4
185	406	BEST 6 students Supplementary	6	0
152	272	POOREST 6 students Supplementary	2	4

Note: The difference in favour of the best six students (Architecture examinations marks in each of the four subjects) is statistically significant at the 0.05 level in all cases.

(Stats. test: Fisher's Exact Probability Test, cf. Siegel (1956) for total accuracy scores and total marks, Architecture examinations and for number of students exceeding/not exceeding accuracy score 27.

DISCUSSION OF RESULTS

As Table 1 shows, there is a marked difference in performance on the A-C test in favour of the architect students both in regard to accuracy and time taken, the largest single difference being for accuracy in the case of the 'divergent' thinking parts of the test.

Within the limits of the comparatively small numbers in the three groups one could say that the test differentiates quite effectively between those who have studied Architecture and those who have not. Put in another way, it would seem that the superiority of the architect students' performance on the test is determined partly at least by their education and field experience in Architecture. If this is the case how is it explained? The answer would seem to be partly in terms of the nature of the material form of the test and partly in terms of the particular kind of thought processes involved in doing the test. The dimensional and other characteristics of the sixteen blocks of the test which the architect student was required to deal with are the same as some of the main characteristics of his work in Architecture, i.e., characteristics of dimension: size, height, shape, and other material characteristics, e.g., solidity, colour. By the very nature of his work the architect is constantly involved in isolating, juxtaposing, categorising and combining dimensions and characteristics such as these, and this is the form which the tasks embodied in the test takes. The architect also has an important role as 'co-ordinator' or manager particularly with respect to larger jobs, e.g., large factories, modern schools. Another test, which we are developing at Manchester, taps the kinds of attributes required for this 'higher-level' co-ordinative activity better than the A-C test and arrangements are in hand to administer it to a representative sample of students. It will be noted that the engineer, in parallel, frequently engages in similar co-ordinative activities, a connection which illuminates this special aspect of the study.

From this it will be seen why, in the first instance, we thought that performance on a test such as the present might be related to the kind of ability involved in Architecture, and also why it was felt that architect students who have more specialised opportunity for dealing with material dimensions such as these, would score higher on the test than non-architect students such as economics and social science undergraduates where the 'facts' dealt with are mostly in verbal form, e.g., reports, estimates.

At this point we must be careful not to give the impression that we are implying that the ability to reach a high performance in a mental test of this kind is found only in architects and architect students. What we are suggesting is that, because of their familiarity through their work with the dimensional and other characteristics which figure in the test, and because their work constantly involves the same kind of mental processes - isolating and manipulating dimensions and other attributes, as in the case of the test - these two factors working together should lead to relatively superior performance on the test by the architect students. From a general point of view, the economics students, and the social science students as a whole, scored well on the test and obviously the same kind of mental ability is involved in both cases:

perceptual discrimination; categorisation or setting up classificatory concepts; clear-headed differentiation in thinking one's way through a particular task. The assumption, however, was that for the two reasons stated, the architect students would do better on the test than the economics and social science students. The results obtained lend further support to this assumption.

So far we have been discussing differences in performance on the test between the architect and non-architect students. We will now consider the difference within the group of architect students, between the six best and the six poorest students in terms of academic assessment in the four subjects in the Architecture Course described above. First, the two 'convergent' thinking parts of the test. There was no statistically significant difference between the scores for the best and the poorest six students for either accuracy or time taken. What difference there was in the accuracy scores was in favour of the best six students in the case of all four architecture subjects. The accuracy scores, however, were crowded so closely near the top of the scale with a range of only 26-30, that it is evident that the number of 'convergent' test-series will have to be increased if any possible real difference in performance between best and poorest architect students on these two parts of the test is to emerge. This is being carried out in the Research Unit at Manchester.

Second, there was a statistically significant difference (.05 level) between both the accuracy scores and time-taken on the two 'divergent' thinking parts of the test for the best six and the poorest six students in the case of all four Architecture subjects. The details can be seen in Table 2.

RELATIONSHIP BETWEEN EXAMINATION MARKS IN THE FOUR SUBJECTS OF THE ARCHITECTURE COURSE

Generally speaking it is found that architect students who do well on one subject tend to do well on the other three. From the nature of the subjects, this is to be expected, as taken together they constitute the nucleus of practical work in the Architecture Course. To clarify the picture in regard to the extent of the relationship we have worked out the correlations between the examination marks obtained by the architect students in the four subjects. These are given in the following Table.

TABLE 3: Correlations between examination marks in the four subjects of the Architecture course

	Architectural Design	Architectural Construction	Building Construction
Architectural Design	-	-	-
Architectural Construction	0.63*	-	-
Building Construction	0.49*	0.53*	-
Supplementary	0.13	0.13	0.12

* Statistically significant at 0.05 level, Spearman's rho cf. Siegel (1956).

As the table shows, the inter-relationship between the four subjects is quite close, but it is not, however, an exact one in the point-to-point agreement sense. The overall picture of academic marks and 'divergent' scores on the A-C test thus suggests that there is a basic ability in Architecture and that this can be tapped by other means as well as conventional assessment or examination.

The discussion has now reached a stage where we can relate our findings on the A-C test to the statement of the problem in the first part of the paper. There it was pointed out that there are two crucial requirements in the measurement of any particular ability by the use of tests like the present. The first of these - that the test should differentiate between those who have had education and experience in a particular expertise and those who have not - is met, as we have seen, by the A-C test. We have also seen that the test takes differentiation a step further and distinguishes within the group of architect students between the best and the poorest in terms of examination marks in four separate subjects on the Architecture course.

At the present stage we are not in a position to say anything about the effectiveness of the A-C test in regard to the second crucial requirement - developing a test which will differentiate between those likely to do well on an Architecture course and those not likely to do well - as we have not yet had the opportunity to try out the test in this way. However, since we now have evidence that ability on the test is related to ability in the four architecture subjects, the prospect of it being effective as an aptitude test for educability in these subjects looks promising. It is, however, a long step from using a test to measure developed ability to using it to measure capacity for the development of such ability. The crucial question here becomes: is the elemental form of the particular ability sufficiently established in student-entrants to architecture, for instance, to enable it (a) to be measured reliably, and (b) to be used as a basis for differentiating in terms of relative scores on the test, between those likely to do well on an architecture course and those not? The scores of the Economics and Social Science students on test give encouragement here. On the whole, as we have seen, they scored well on the test, so we know from this (and from independent score-data) that ability on the test does not depend alone on architectural education and experience. Furthermore, the distribution of the Economics and Social Science students' scores was fairly normal, in statistical terms, which suggests that some kind of particular ability is involved in performance on the test. It is this initial measurable ability which would provide the basis for attempting to use the test to appraise architectural aptitude, in other words, as a predictor of the educability of the architect student-entrant.

With this second stage of the investigation in mind the A-C test has been administered, on a trial basis, along with several other psychological tests, to the annual student intake to the Manchester University School of Architecture. The students' headway at the different examination stages on the course is being compared with their pre-entry scores on the tests. The result will show how far the A-C test alone, and in conjunction with other tests, is capable of predicting success on the course.

In concluding this part of the discussion we would like to draw attention to what is regarded as an additional important point about the A-C test. This is in regard to what is usually considered to be the most important subject on the course: Architectural Design. The test is particularly effective in identifying students with greater and lesser facility in this. In the case of students with lesser facility, poor performance on the 'divergent' thinking parts of the test and poor headway in Architectural Design seem to be due in part at least to the same short-comings: rigidity of thought and lack of capacity to range round flexibly, i.e., 'diverge' when thinking over a particular problem. Usually, such students also score much higher on the 'convergent' parts of the test than on the 'divergent'. It would thus seem that 'divergent' thinking is closely related to creativity in Architectural Design in the sense of intellectual resourcefulness and fluency in originating and developing ideas. 'Convergent' thinking on the other hand, the type of thinking called for in handling logical-type problems which leads, in terms of previous education or training to one right answer only, would seem to have an inhibiting effect on Design where an Architect tends to think preponderantly in this way most of the time.

As already mentioned, the electrical and the mechanical engineers will see some parallels with their own field in regard to features of ability which the A-C test and architecture have in common. The parallels in the case of electrical engineering can be seen at two levels. At the first level we have similarities between the task-demand of the A-C test as a whole and that involved in the early stages of engineering education. In the case of the A-C test the task figures as a set of blocks which the testee is obliged to organise in terms of different concepts. This can be seen as an analogue of what is involved in the early stages of learning about components in electrical engineering. In circuitry, for example, there is a range of components: tube, capacitor, reactor, etc., each with one or more related functional concepts, e.g., rectification, amplification, in the case of tube. The beginner in engineering has to learn to relate the appropriate concept to each circuit component in terms of its particular function in the circuit as a whole. Put briefly, the same mental processes are involved in both: perceptual discrimination and clear-headed differentiation in relating concepts to tangible objects - components in the case of electrical circuits, blocks in the case of the A-C test. In both also, the appropriateness of the concept which is related to the particular object must be seen in terms of what is involved as a whole.

At the second level the parallel between the ability involved on the A-C test and electrical engineering is in regard to capacity for producing and developing ideas, particularly in 'design and creativity'. Concern about this rather neglected aspect of electrical engineering education is now regularly voiced at annual conferences, Hartley (1966). This kind of ability figures directly on the 'divergent' part of the A-C test in the sense that the testee is obliged to range round in his thinking and sample possibilities in his search for the relevant factors in arriving at a solution to the particular sub-test on which he is engaged. In design in electrical engineering there is the same kind of demand - though much more complex - and this is involved all the way from the planning of power stations and distribution systems to the design of switchgear and control apparatus.

In architecture, electrical and mechanical engineering, and a number of other professional fields, the problem of how to appraise creative aptitude is a most difficult one. Any new approach, in terms of psychological testing or other form, would seem welcome even if it only led to clarification of some aspects of the problem.

With regard to the experimental design and test selection and construction in the research described above it should be pointed out that this was the result of a period of protracted and intensive study.

Experience suggests that such research should be carried out on the basis of very close co-operation between the subject-specialist and the expert in the necessary measurement techniques, since it is unlikely that these kinds of specialized knowledge will be found, initially at any rate, in the same person, except in a very few departments. It should be stressed to workers in other fields, therefore, that work on this basis is likely to occupy the time of researchers of both types very fully for a considerable period if worthwhile results are to be achieved, and it will therefore be fairly costly.

Chapter 5. EDUCATIONAL FACTORS IN CREATIVITY

(a) INTRODUCTION

Creative potentiality, or creative disposition, has, as we have seen in the earlier chapters, been the subject of considerable investigation by one method or another. There is an increasing knowledge of the kinds of traits involved in individuals recognised as having higher probability of producing novel and original solutions to society's multifarious problems and needs. As we have argued above, some of the traits are best defined as thinking skills or strategies, often identifiable as intellectual abilities such as 'convergent' and 'divergent' production as outlined in Chapters 3 and 4. Other traits are in the nature of the personality characteristics as considered above in Chapter 2. There are also traits in the motivational category, including needs, interests and attitudes, some of which are discussed, tentatively, below. From the knowledge we have about the characteristics of potentially creative individuals and from the testing instruments and methodological techniques and expertise developed from creativity studies, there is some basis from which to approach the problem of education and training in creativity. We have tried to indicate, below, how some investigators have utilized this basis with both enterprise and ingenuity. It should be made clear at the beginning, however, that at present we have no very decisive information as to which of the personal traits and abilities are most effectively trained and developed.

As we suggested in our introductory chapter, studies of the development of creativity have been, in general, much more tentative, desultory and inconclusive than the studies which have been primarily concerned with the establishment of what we have termed the special abilities and personality characteristics of creative individuals. It is quite natural that the research has often taken the form of an extension of the studies of special abilities in creativity and of the studies of personality characteristics, using the instruments, techniques and methodologies developed in these studies. Perhaps the best studies to consider first are the large-scale studies of 'institutional' factors which have been carried out recently in the United States. These are particularly valuable as introductory studies to this chapter since they raise some of the important basic issues in the development of creativity in the content and context of higher education.

(b) INSTITUTIONAL FACTORS

Benson Snyder (1967) in a substantial article in Universities Quarterly examines the effect of 'the institution, the college curriculum and setting', on the development of creativity. He suggests that students in some particular educational disciplines and fields of study may need greater freedom to give time to intellectual risk-taking and to 'playing with ideas'. "The need for closure, for making a commitment to one of several possible solutions, may be a more crucial experience in the undergraduate education of engineers than in the education of scientists. The student scientist may have and need greater sanction and freedom for intellectual risk-taking than his engineer counterpart. This at least raises the interesting possibility that creative solutions or formulations by engineers may involve 'intolerance' rather than 'tolerance' for ambiguity. Creative activity for student engineers may involve a cognitive and emotional style that differs significantly from nascent scientists. One style is not better than the other. Simply, creative activity for the engineer and the scientist may be qualitatively very different undertakings. A further distinction needs to be made. It is at least plausible that an antagonism may exist between professionalism, the achieving of professional status in the arts, science and engineering, and developing creative competence in these fields. Education may be more focussed on the former than the latter."

In his large-scale investigation Snyder posed two major questions: (1) "What happens to 'creative' students at an institution which focusses on engineering and science?" and (2) "What is the effect of such an institution on 'creativity'?" Snyder used an operational definition of creativity based on the use of three scales: Thinking Introversion Scale, Complexity Scale, Impulse Expression Scale, derived from the Omnibus Personality Inventory. Mean scores for the three scales were obtained from 721 members of the freshman class at Massachusetts Institute of Technology. These mean scores were then compared with mean scores for the same scales obtained at other institutions of higher education in America.

One of Snyder's overall conclusions from this study was that M.I.T. is losing three times as many students who, when freshmen, preferred to investigate 'new solutions' and to take intellectual risks, as those students who preferred a well ordered and regulated life with tangible results.

Snyder also investigates, tentatively, the institutional supports and stresses which influence the development of creative talent. To quote: "It is probable that the variety of academic communities provides significantly different environments for the creative artist and the creative scientist. Especially in a science-oriented university there is high group approval for the innovator, the man who questions basic formulations and comes up with a new synthesis of theory. This is particularly evident when a new theory leads to a new piece of engineering hardware. On the other hand, there are examples of creative artists in liberal arts colleges who have met with a crushing ostracism from their immediate environment precisely because of their creative efforts."

Snyder goes on to investigate the institution's impact on highly creative students and the institution's role in developing creativity, by considering case history data of individual students. These suggested that students develop "a variety of strategies to deal with dissonance between expected present, actual present and hoped for future." To quote further: "Certain strategies, certain solutions used by students have much higher survival value in one academic setting than in another or in one academic field than in another. The institution more than the student sets the odds on the various strategies and coping patterns that will succeed. Further, an invisible curriculum may play as important a role as the formal curriculum in determining which strategies or solutions are maximally adaptive. Those strategies having survival value for the present do not automatically serve the student well in mastering his field, or in developing his intellect. It is precisely this that challenges educators to consider the consequences of their curricula for the development of excited, imaginative, and concerned students."

Snyder's study provides a good example of the use of a developed measuring instrument, the Omnibus Personality Inventory, in a large scale study of creativity in institutions in higher education. Although it presents somewhat limited and tentative answers to problems of the development of creativity in these institutions it represents an interesting pioneering pilot study. It raises a number of important problems and should stimulate other workers to carry out parallel studies using other instruments and techniques and, ultimately, framing more precise hypotheses.

A similar study is that described by Heist (1967). In his detailed and large-scale research Heist investigated students who transfer, or drop out, from the college of their original choice. This study was carried out in a number of institutions of higher education.

The findings from several research projects at the Center for the Study of Higher Education provided information about the number of young people of high ability and talent who became dissatisfied with their first-choice college and left. Among such withdrawing students in two long-range studies, large percentages were identified as having high potential for creative involvement and expression.

The proportions of identified creatives withdrawing, as observed in seven quite dissimilar institutions, ranged from approximately 50 per cent to 80 per cent. In five out of seven of the particular institutions included in these analyses, a significantly higher proportion of the creative students on each campus left than was the case with dropout students not so identified. Heist submits that the major conclusion to be drawn from the data was that the students ranked as creative or identified by measured characteristics of creativity left some colleges more frequently than or as frequently as did all other students not so identified. This study raises a number of important considerations. Heist points out that the particular method of identification of the creative students in some of the sub-projects of his main investigation, a criterion based on the use of the A.V.L. Study of Values (Allport, Vernon, Lindzey, 1951), provided no assurance of actual creative production by the people identified, "if and when they had the opportunity to perform as the criterion scores would indicate." However, the pattern of scores obtained for the high achieving dropouts was almost identical to the one reported by MacKinnon (1960) as typifying the values of recognised creative adults in several different fields.

Heist's general findings were also supported by some special studies carried out within the general context of his research, which investigated creative students classified by peer and faculty nominations. Some of these students also scored highly on scholastic aptitude tests.

Heist also includes three interesting and striking individual case history sketches in his substantial report. He suggests that the experiences of these three people were similar to the experiences of numerous other students identified as having unusual creative potential. A number of students left the college world after one or two years, or moved from one campus to another "seemingly seeking an education that did not exist." Some "felt or knew that they were in the 'wrong' institution but, through a combination of circumstances, seemed unable to move to a more appropriate setting". Others "finished out their undergraduate careers, frustrated and dissatisfied for the most part at not receiving what they expected in the way of a meaningful education, and eventually moved into other majors or other media to gratify their needs for expression and involvement."

There are some important considerations arising from Heist's research from the point of view of this monograph. It would be interesting to have this type of large-scale study carried out at British institutions, using similar or additional criterion instruments for identifying creativity. Heist's work undoubtedly reflects the particular structure and culture of institutions of higher education in the United States. It is highly probable, however, that some of the variables e.g., frustration, dissatisfaction, discussed by Heist operate in institutions of higher education in the United Kingdom although they will be expressed in the particular structure and culture of these institutions.

Studies of this type must be regarded as preliminary and tentative since they involve the structure and educational policies of institutions of higher education. Teaching methods are the subject of a great deal of contemporary review and speculation in education and psychology. Creativity research, in this respect, is best regarded as a contributory aspect in a general federation and consortium of studies. However, some specialisms of approach and research orientation must be claimed by the research worker concerned primarily with 'creativity'. A general review of studies of the type carried out by Heist demonstrates the importance of the preliminary identification of creative talent. A special need is for the development of test construction - the production of adequate measuring instruments for use in basic research. As we have discussed in chapters 2, 3 and 4 this is a special aspect of the general problem of intelligence, ability and personality theory.

Another specialism is the identification of teaching methods, environmental and learning theory factors e.g., individual strategies, which are most effective in the development of creativity. The environmental factors are considered in the final chapter of this monograph. The remainder of this chapter is concerned with teaching and learning factors. As we have tried to indicate below these two are not always clearly distinguishable in the development of creativity. Rather than attempting to carry out separate discussions under the individual headings of teaching and learning, which would be somewhat unrealistic both in view of our present knowledge of creativity and in terms of the nature of the subject-matter itself, we have discussed the relevant research in the more general context of special psychological factors and methods of approach.

(c) THE STAGES OF CREATIVE ACTIVITY

Some research workers have approached the problem of education and training in creativity by considering the ways in which creative thinkers describe their activities in writing e.g., a poem or novel, in carrying out scientific research, or in mathematical discovery. Some good examples of this type of approach are found in a study by Ghiselin (1955) in which a number of creative thinkers discuss the "ways in which they think" when they are engaged in scientific and literary production. In a similar way, McKellar (1957) in his psychological study Imagination and Thinking devotes a chapter on the "conditions of creativity" in which he gives some interesting field examples of creative thinkers at work. Koestler (1962) also gives a large number of case history studies of the ways in which the creative thinker tackles a specific problem.

Koestler includes, in his well documented source-book, a detailed treatment of Archimedes' famous 'Eureka' experience. In his case-historical studies of poets, novelists, artists and scientists Koestler cites Poincaré's description of his experience in carrying out some original work in Mathematics. This account has been summarized below.

Poincaré was trying to prove that it was impossible for there to be any functions of the kind which are called Fuchsian functions. Every day over a considerable period of time he worked on a large number of combinations but was unable to obtain any conclusive results. One night he took some black coffee before retiring. He could not get any restful sleep but he underwent an experience which was, however, invaluable. To quote: "Ideas rose in crowds; I felt them collide until pairs interlocked, so to speak, making a stable combination. By the next morning I had established the existence of a class of Fuchsian functions, those which come from the hypergeometric series; I had only to write out the results, which took but a few hours." c.f. Koestler (op. cit.).

Poincaré suggests that creativity, discovery, sudden illumination, depends upon certain conditions:

(i) A protracted period of diligent conscious work e.g., the collection of data, a definition of the problem, several attempts to reach the solution.

(ii) The role of the unconscious, which Poincaré considers to be of prime importance. The emergence of an appropriate hypothesis which gives rise to a conscious reaction - a receptivity to the sub-conscious ideas which are distinctly relevant to the problem in hand.

(iii) The application of special techniques and methods to the ideas developed from sub-conscious levels. This final stage itself may call for considerable time and effort and may involve the solution of difficult if perhaps 'convergent' problems.

There have been several efforts to carry out experimental investigations of the stages of creative thought as outlined above, although these have not been conspicuously successful. One particular research enquiry which deserves some attention, however, is that of Patrick (1935) (1937) (1955). Patrick investigated the writing of a poem, the painting of a picture and the attempt to solve a scientific problem. Patrick's studies were based on two groups of subjects. One group was composed of specialist professional experts and the other was composed of non-specialists. The groups were carefully matched for homogeneity in terms of the variables of age, intelligence and sex. In the experiment the subjects were present with selected stimulus objects: a poem by John Milton and a landscape painting. The subjects' task was to actively respond to the stimuli. While the subjects worked they were encouraged to discuss their tasks, their problems and the ways in which they felt inclined to tackle them. The experimenters observed the subjects' activity using several reporting devices. There was no time limit in the experiment and at the end of each experimental session each subject completed a protocol questionnaire on 'methods and problems of work'.

From her detailed experimental results Patrick concluded that creative thought passed through several distinct stages similar, in fact, to those outlined by Poincaré. Patrick listed the stages as Preparation, Incubation, Illumination, Verification. These are defined roughly as follows:

> Preparation. Where the subject makes himself familiar with the problem situation and its materials.
>
> Incubation. At this stage the problem begins to form an outline and definition. Suggestions as to possible solutions arise. It is possible, of course, that these may be many and varied.
>
> Illumination. A specific goal is defined and the subjects begin to work towards it.
>
> Verification. The results are fully worked out, analyzed and completed.

Other experimental investigations have tended, in general, to support Patrick's conclusions. It has been suggested, however, that the stages of activity (as outlined by Patrick) do not always occur in a strictly sequential order. There are usually important differences in the ways in which individual thinkers work through the particular stages. One subject may work backwards and forwards through the stages before reaching a definite and complete solution. Another may spend a long time over one particular stage and then turn back to an earlier stage in a deliberate way. Yet another individual may work through the four stages in a continuous movement which seems to embrace more than one stage at a time.

More recent investigations than those of Patrick have tended to concentrate on specific psychological functions e.g., 'imagination', 'cognitive styles', 'set', 'rigidity', 'personality structures', some of which have been discussed at length above, which play important parts in the 'stages of creative thought' as outlined by Poincaré and Patrick above. The method adopted by these writers, however, serves the useful function of providing a general framework within which some of the important contemporary work can be discussed. One particular case in point is the research carried out on the concept of 'set', which, as was suggested in the introductory chapter, has led to important developments in the field of creativity (above chapter 1, p. 8).

(d) THE CONCEPT OF 'SET'

Gibson (1941) in his comprehensive review of the concept of 'set' draws attention to its general importance in psychological theory. Gibson also draws attention to the fact that some experimenters, particularly those working on conditioning, regard the concept as unsatisfactory, and only use it where the facts make this unavoidable. He then suggests that other experimenters, particularly those interested in thinking, use the concept freely, although with great variations in terminology. As examples of this, Gibson draws attention to associated concepts such as direction, need, hypothesis, scheme.

Gibson goes on to analyse the variation in the meaning of the concept 'set' itself as used by different psychologists. He submits a number of examples of the way in which the concept of 'set' has been applied. To quote: "The term 'set' has been applied: to neurotic anxiety, to primary or immediate memory, to a partial insight or way of seeing a problem, to sensory hallucinations, to the incubation process in reasoning, to the atmosphere induced by logical premises, to the time-error of psycho-physics, and to Pavlov's delayed conditioned reflex, Thorndike's spread-of-effect, and Tolman's cognitive expectations".

As some writers have noted, it is not easy to differentiate between the concepts of 'set', 'transfer of training', and 'stimulus situation', e.g. McGeoch and Irion (1952), Bugelski (1956), all of which are of basic importance in creativity. Part of the difficulty arises from the fact that the concept of 'set' is an amorphous notion.

Gibson points out that a few writers have offered definitions of the concept of 'set', although, he submits: "the definitions are always dictionary definitions in the sense that they employ synonyms rather than specify experimentally definable characteristics. 'Sets' are usually 'tendencies', 'dispositions', or 'readiness', and their effect on activity is one of 'facilitation', 'selection', 'determination', or 'guidance'." Gibson then points out that other writers, e.g. Young (1925), Mowrer (1940), and Dashiell (1940), have given a series of illustrations of what they mean by 'set' and have discussed the common features which emerge. He submits that the lists which these writers have drawn up are interesting, not only in themselves, and what they have in common, but even more for the differences between them. Any common core of meaning is difficult to trace.

As we suggested above, however, in general we may say that writers using the concept of 'set' are referring to a factor, or factors, which facilitate responses for which a subject is prepared, and which tend to inhibit any competing responses. It is interesting to note the way in which different writers have arrived at the concept from contrasting approaches. Usually, experimentation involving the concept of 'set' has been concerned with preparatory adjustments for the performance of specific tasks, e.g. reaction-time experimentation, May (1917), Watt (1905); controlled association, May (1917); the judgment of lifted weights, Payne and Davis (1940). 'Set' in problem solving has been investigated by giving the subject a number of problems which require a specific solution, and then presenting him with a problem which requires a different kind of approach, as in Luchins (1951). In this experimental situation one may note such factors as: errors made by the subject; increased time taken by the subject to reach the correct solution. These factors have then been related to the subject's tendency, or 'set' to tackle the new problem by the method appropriate to the old problem.

This latter type of experimentation considers the concept of 'set' from a specific situational point of view. It is possible to draw a distinction between such comparatively specific 'sets' which may be attributed to instructions given to the subject immediately prior to the problem-solving situation, and the more continuous and persisting 'sets', which the subject brings to bear on the problem-solving situation, of the type investigated by Harlow (1949). Harlow calls these "learning sets" and it is submitted that his investigation of them constitutes an interesting departure in the study of creativity.

Harlow (1949) describes the intensive research carried out by himself and his many co-workers on the formation of 'learning sets'. His experimental findings suggest that the human child, and the rhesus monkey, if given experience in mastering a series of discrimination tasks, learn how to perform not only separate identical tasks, but also how to attack similar tasks in an efficient way. The results which Harlow has collected (largely from discrimination tasks), suggest that the subjects had acquired a transferable technique of observing relevant cues. In his experiments at Wisconsin, with his very ingenious apparatus, Harlow presented young children (and monkeys) with a series of discrimination problems. The apparatus allowed a stimulus tray to be pushed within the subject's reach and removed once the subject had made his choice. On the tray were two food-wells with removable covers, between which objects (e.g. food items) could be interchanged in random order. The apparatus was constructed in such a way, that the experimenter was able, unseen, to place food in a particular well and then allow the subject access to the tray. In this situation the subject usually responded by removing the well-covers and taking the food from the particular well. In one series, a number of well-covers were designed by Harlow to provide cues to the presence or absence of food items in the well beneath. To prevent unintentional cues from his own person, the experimenter operated the apparatus from behind a one-way vision screen.

In this particular series of tasks, Harlow's method was first to present the positive (i.e. food-accompanying) and negative (i.e. non-food) well-covers in varying positions in such a sequence that it took the subject many trials to select the positive well-cover consistently. In the ensuing presentations, Harlow used two different well-covers so that learning had to start again. Gradually, in a long series of such tasks the learning became more rapid until finally the first trial on each was usually sufficient to establish the positive cue for that task, as was shown by the score of correct responses on the second trial of each new task which was as follows:

50% in the first few tasks

70% after 25 tasks had been mastered

80% after 100 tasks had been mastered

88% after 200 tasks had been mastered

95% after 300 tasks had been mastered

In a later paper, Harlow (1950) made an analysis of the factors in the improvement and showed that the subject learned to use the positive well-cover as his cue, ignoring its position, and also learned to abandon his initial preference or hunch as soon as it was proved incorrect. Harlow submits that his findings can be generalized to social situations, and suggests that the young children, and monkeys, learned something about the 'lawful and dependable character' of human behaviour in the laboratory, but at the same time, developed a degree of flexibility. For instance, Harlow points out that when the experimenter reversed the cues in the middle of a task the subject quickly learned to notice the change and to readjust his choice. In this connection, it is noted that Riopelle (1953) has described an experiment in which monkeys, already experienced in discrimination tasks, were given a regular schedule of six tasks daily, the last one being the same as an earlier one of the same day, but with the cues reversed. Riopelle was interested in the question of whether or not the monkey would respond as he had learned to do earlier in the day. The results showed that at first, the monkey responded as he had done to the earlier task, but after many days of practice he learned to approach this task as a new problem in which the first trial was purely exploratory. He learned not to carry over specific responses to certain cues, but to attack each task as new and independent though of a familiar sort. This sort of extended-series transfer experiment has been carried out on young children and chimpanzees, with similar results. c.f. Hayes, Thompson, and Hayes (1953).

The main relevance of Harlow's experiments for this review is in connection with how, in general, 'sets' are established through learning, and, in particular, how an automatic, unthinking type of response-behaviour to particular cues yields to a more conditional, less rigid type, when particular sequences in the learning programme have been followed. This would suggest that careful planning of such sequences in, for instance, a student's course in a given subject, could help to facilitate the development of creative responses in learning.

Harlow's work suggests that the experience gained in the process of solving earlier problems should be used to learn ways of reaching the solution of later problems. The emphasis is on solving problems by the effective transfer of a process learned over a range of related but varying problems. In this connection Wolfle (1935), suggests that if we are to learn to apply a principle in new situations we need to develop it from experiencing specific instances in varying contexts. Wolfle's early work, carried out in the context of higher education, suggests that repetitive drill is much less effective than varying problems in developing principles which can be applied to new situations.

In his review, Gibson admits that 'sets' may be unverbalized and even below the threshold of awareness. He argues, however, that the most crucial ambiguities in connection with the concept derive from the relation of 'set' to past experience or habit, and from the characterization of 'set' in particular instances, as being 'voluntary' or 'involuntary'. These are precisely the aspects of 'set' in which we are most interested. We are also interested in the involuntary nature of such learning 'sets'. It is important, therefore, that we give particular attention to Gibson's comments on these aspects. To quote: "The most crucial ambiguities, however, have to do with the relation of 'set' to past experience and with the characterization of 'set' as voluntary or involuntary. Both problems require an experimental analysis which systematically varies the attitudinal factor. The voluntary - involuntary problem requires the specification of definite criteria and the consistent use of these instead of merely the words themselves".

We are now in a position to examine some of Gibson's analyses of the experimental investigations of these particular problems and attempt to relate them to our own investigation of the development of creativity. We are concerned with the inhibiting effects of learning 'sets' sometimes established without the subject's awareness, over comparatively long periods of time, and we must try to relate these to past experimental factors in the subject.

In his review Gibson describes the earlier attempts by Ach (1910) and Lewin (1922) to examine the strength of a 'determining tendency' compared with that of an 'associative tendency' in order to measure voluntary or 'intentional' processes in comparison with 'associative habit'. An example of the work of Lewin is that in which a new 'intention' to rhyme a nonsense syllable was compared with the tendency to give its habitual associate. Gibson points out that the experiment was intricate, laborious, and only indifferently successful; it led Lewin to reject the associative-tendency hypothesis entirely.

Gibson goes on to describe how Hilgard and Humphreys (1938-b) took up the associative-tendency hypothesis again and investigated it in a conditioning experiment. Their results supported the hypothesis and so were in disagreement with those of Lewin. Hilgard and Humphreys' experiment was essentially a conditioned eye-blink discrimination series, based on two easily discriminable light-stimuli. Reinforcement was by a puff of air to the cornea.

Gibson goes on to describe a further experiment by Hilgard (1938-a) in which two groups of subjects were given instructions which produced 'voluntary intentions' these being in contradiction with the associative tendencies established by systematic training. One group was set to blink to what had earlier in the training period been the negative stimulus, and to inhibit any tendency to blink to the positive stimulus; the second group was set to inhibit all blinking. The results showed that in the case of both groups the conditioned tendencies were not extinguished by the 'determining tendencies'. The blinks to the positive stimulus continued, and even increased in amplitude, (despite the 'voluntary intentions', although somewhat reduced in frequency). The blinks to the negative stimuli, on the other hand, appeared, or did not appear in accordance with the instructions in regard to 'voluntary intentions' given to the subjects. Gibson points out that one important conclusion which may be drawn from this is, that while a negative tendency may operate to some degree against the positive conditioned tendency, the reduction in frequency of conditioned response is not statistically significant. He then goes on to point out that conditioning can be established in many experimental situations in the face of inhibitory 'intention'. He submits that there is evidence that human subjects usually adopt such an arbitrary set in a conditioning experiment.

Gibson also argues that conditioning is not always dependent on a positive 'intention ', and contrasts this particular situation with that in verbal learning, where 'intention' to learn is clearly important.

These findings raise a number of important issues: the motivational factors; the relative effects of long-term and short-term 'learning sets'; the differences in subject matter, as differentiated in particular experimental situations. A serious investigation of the concept of 'set' inevitably involves one in motivational issues. The relative effects of long term 'learning sets' and the more short-term 'learning sets', as investigated tentatively by Hilgard and Humphreys are most interesting. They require further examination and discussion as they have important implications for education and training. It was noted above that Riopelle sometimes arranged the experimental situation so that the cues were reversed. According to Osgood's theory of 'transfer surface' this was a condition for producing negative transfer. As we saw, this was precisely what happened at first. The subject had difficulty in dealing with the reversed cues and continued to select the original cue. After practice, however, the subject acquired a facility for dealing with reversal problems and learning to handle them and shift with relative ease. The subject became flexible in dealing with discrimination reversals. An educational implication stemming from this finding is that practice in cue reversal leads to flexibility in problem solving.

In summary we may say that learning set theory represents the transfer between many problems of a single class over a considerable time span as distinct from short-term studies of transfer based on only a few problems. In the course of acquisition of a given learning set, the learning curve is observed to shift from the characteristic S shaped curve to one in which the curve develops sharply but is negatively accelerated.

The special features of this learning curve permit certain predictions to be made as to the relative efficiency of certain aspects of learning in problem solving. In a later paper Harlow (1959) suggests that one technique for maximizing the efficiency of learning in problem solving was to run the subject, on a given problem, through those trials on which gain in learning was greatest. Once the subject reaches a point of diminishing returns, in terms of gain in learning, it is inefficient to allow the subject to persist on this particular problem.

Learning set theory also enables predictions to be made as to the effect of motivation on problem solving. During the early stages of learning a series of problems, learning is observed to be slower and the subject makes a greater number of errors. These errors may prompt the subject to refuse to make more responses as well as to participate in the random behaviour characteristic of responses in frustrating situations. Harlow makes the prediction that there would be fewer emotional responses as a learning set develops as a result of the fewer errors produced. He also suggests that the difficulties experienced by some elderly people in new problem-solving situations may be related more to frustration developing from making errors than to any limitation in actual learning capacity. This is certainly an interesting and valuable suggestion which is worthy of further study. This type of frustration is quite possibly a serious inhibitor to a good deal of creative behaviour.

Harlow (1959) develops his work on learning sets to incorporate a detailed analysis of the types of errors made by the subject in discrimination problem solving situations. This analysis has led to the development of error factor theory, a concept which has been used to explain a variety of learning set phenomena. Four types of error factors, present in the typical discrimination problem-situation, have been identified and they are termed: stimulus perseveration, differential cue, response shift, and position habit errors. Harlow suggests that learning in problem solving involves the "progressive suppression of the various error factors".

Finally, Harlow's findings are also relevant to work carried out on the behavioural problem of 'insight'. Various authors have listed the chief descriptive characteristics of 'insight' and most of these draw attention to the rapid, often dramatically sudden, solution of a problem. Köhler (1957) for instance, defines "the appearance of a complete solution with reference to the whole layout of the field". Osgood (1960): "the solution of the problem precedes the actual execution of it". Yerkes (1943): "the solution is suddenly, directly and definitely carried out". In most of the accounts of 'insight' the successful response appears suddenly, it is easily repeated in future trials and is not easily forgotten or eliminated. As we have seen above in our consideration of the 'conditions' of creativity, this kind of situation is characteristic of the 'eureka' sensation in creative discovery. In view of Harlow's findings it would appear that 'insight' might be, demonstrably, a result of extensive practice on related problems.

The research work carried out into the concept of 'set' sheds light on the processes of 'preparation', incubation and illumination as discussed by Poincaré and Patrick (above) and illustrates how these may be discussed in the terminology and context of current psychological research.

(e) THE INTOLERANCE OF AMBIGUITY

As discussed above, Benson Snyder in his large-scale study introduced 'tolerance' and 'intolerance' for ambiguity as a distinctive concept in the development of creative thinking. This is a particularly important notion in several respects. It introduces what psychologists have termed 'autistic' thinking, an activity which takes such forms as fantasy, wishful thinking, reverie and day dreaming. The associations which are formed in autistic thinking are considered to be determined by such stimuli as 'needs' 'wishes' and 'conflicts'. These are the stimuli which the subject brings with him into the learning situation and which may be regarded as distinct from the external stimuli provided by the normal and general cues of the learning situation.

As we suggested at the beginning of this chapter needs, interests and attitudes are important factors in the development of creativity. It is within the context of such psychological concepts as 'autistic thinking' that these traits are expressed. There has been a considerable amount of research dedicated to this aspect of psychological enquiry and this has an important bearing on creativity. In general this research tends to identify the 'inhibitors' to creative thinking, although some writers have shown how it may contribute to the study of the origin and genesis of ideas and their development. Two of the more important papers in [illegible] general research area are summarized below.

In the first interesting study, by Frenkel-Brunswik (Mechanisms of self-deception, 1939) the aim was to compare the actual conduct of a group of students, as observed by four independent judges, with the students' own statements about their conduct. Besides asking students to describe their own behaviour, questions were asked about the 'guiding principles' of their conduct in general and their 'demands upon the environment', that is, the way they perceived their immediate working environment and what changes they would like to make in it. By this approach an appraisal of certain personality factors of the subjects concerned was also made possible.

The results, based on about 40 subjects, showed that the functional realities of one's behaviour are distorted when they enter consciousness and are verbally reported. Several specific mechanisms were identified by the writer:

(i) 'distortion into the opposite',

(ii) exaggeration,

(iii) omission,

(iv) 'apologetic camouflage',

(v) tendency to minimize.

The writer goes on to make some interesting comments about the modification of behaviour in respect of these mechanisms. Attention is drawn to the tendency to perceive the environment in terms of one's own needs. Self-perception and the perception of the environment tend to merge in the service of these needs. Here, then, is a rationale for perceptual distortion.

An interesting aspect of Frenkel-Brunswik's work has been the connection which has been suggested between studies of perception, and the personality studies of Freud, particularly in regard to the relationship between perception and the ego. The function of the ego is seen mainly as the achieving of a compromise between the instincts on the one hand, and reality and ethical and moral demands on the other. Impulses are exposed to criticisms and are either rejected or modified under the pressure of the 'reality principle' which is considered by Freud as a basic principle of mental functioning. The neurotic is described as "turning away from reality" and as being unable to "dethrone the pleasure principle" in the face of reality demands.

The first nine defence mechanisms, regression, repression, reaction formation, isolation, undoing, projection, introjection, turning against the self, and reversal, are regarded as pathogenic and as closely related to the formation of neuroses and psychoses. However, all of these are found, at least in some degree, in the development of the normal personality. An interesting relation between this kind of theory and our own research is that we may ask the question: "Do mechanisms of this kind operate in creative problem-solving particularly in the early stages of the development of ideas e.g. Poincaré's 'incubation' stage, for instance?" And if so, "How influential are they?" These are, of course, highly speculative questions. They form the basis for an extension of this type of research into the area of problem solving behaviour in creativity and relate to the environmental factors discussed in the final chapter. It is perhaps sufficient here to note that repression consists of a process of forgetting which the subject is not aware is going on; or failure to be conscious of internal factors or events connected with particular aspects in the creative situation. The question raised by this consideration and by Frenkel-Brunswik's paper is, in general: "How far is this kind of factor present in problem solving situations in creative behaviour particularly when the stimulus situation is ambiguous?"

In the second study, also by Frenkel-Brunswik (1951) a schematic description and evaluation of the overt behaviour of a group of adolescents, and of the motives underlying the behaviour, was made by adult observers and by the adolescents' class-mates. This was carried out over a period of eight years. Detailed self-evaluations by the children were also collected. The complete material was analyzed in an attempt to examine the relationship between defence mechanisms and perceptual mechanisms of self-deception. An interesting point which emerged was that the greater the definiteness, exaggeration and lack of reservation in the self-description of favourable traits in a particular adolescent, the less likely were similar judgments in the same unambiguous form to be found in the description of him by his class-mates.

In her discussion Frenkel-Brunswik points out how inadequacy of response to reality-demands operate in more than one area of personality. Specific forms of reaction such as orientation towards concrete detail (stimulus-boundness) tend to occur again and again in particular individuals in contexts seemingly far removed from each other. Inclination toward mechanical repetition of faulty hypotheses, inaccessibility to new experience, satisfaction with the subjective and at the same time, the unimaginative, over-concrete or over-generalised solutions, all appear to be specific manifestations of a general disposition in certain groups of individuals, such as the ethnically prejudiced, which influences their approach to emotional and social, as well as more purely cognitive problems.

Frenkel-Brunswik cites evidence, in certain groups of subjects, of intolerance of ambiguity in the perceptual and judgmental as well as in the emotional and social areas. To quote: "In these individuals there is, on the surface, a rigid, unambiguous adherence to cultural and conventional values, but this combined with an underlying destructiveness towards these same values; this combination of opposites is in contrast to the establishment of a healthy 'medium distance' to the culture".

And again: "Similarly an underlying ambivalence toward the parents is split into a positive and a negative side and expressed through alternative media, e.g. stereotyped and exaggerated admiration in response to direct questions, combined with the conception of punitiveness and harshness in parents, revealed in the indirect material. 'Medium distance' is again lacking, and feelings are expressed in terms of the ends of the continuum rather than of a continuum proper".

And again: "Perceptual stimuli not too familiar, and lacking in firmness and definiteness, seem to be more disturbing to the rigid, prejudiced group. In experimental situations involving a change of stimuli this disturbance is expressed either in a persistent use of the name of the object originally shown or in a bout of random guessing. In either case there seems to be an effort to replace the vaguely known and structured objects".

"In brief, the group of which we speak here shows emotionally dramatized responses to middle class values, parents, out-groups and people in general as well as to perceptual and cognitive material especially if it is vague or otherwise threatening. The choice is between total acceptance and total rejection; if the two co-exist they do so in different layers of the personality".

"Rather than a conscious co-existence of acceptance and rejection leading to qualified feelings and statements however, we find avoidance of complexities on the surface, with chaos lurking behind and breaking through the rigidly maintained facade. With internal conflict being as disturbing as it is, in the rigid group, there apparently develops a tendency toward denying external ambiguity as long as such denial can be maintained. Underlying anxiety issuing from the confusion of one's social identity and from other conflicts is apparently so great that it hampers individuals in this group in facing even the purely cognitive types of ambiguity. The mechanism discussed is somewhat related to what Postman, Bruner and McGinnies (1949) have called 'perceptual defence'. A desperate effort is made to shut out uncertainties the prejudiced individual is unable to face, thus narrowing what Tolman has called the 'cognitive map' to rigidly defined tracks". Finally; "Persons with less underlying confusions on the other hand may be able to afford to face ambiguities openly although this may mean at least a temporary facing of conflicts and anxieties as well. In this case the total pattern is that of a broader integration of reality, in which no parts are left out, and thus a more flexible adaptation to varying circumstances".

This paper raises questions similar to those raised in Frenkel-Brunswik's earlier paper "Mechanisms of Self Deception" discussed above (p. 53-54). The variables discussed by Frenkel-Brunswik are examined in the context of prejudiced and pathogenic subjects but as pointed out they may be found, at lease in some degree, in the normal personality. It would be interesting to see scales of measurement, developed on the lines investigated by Frenkel-Brunswik, used in correlation with the subject's performance on creative problem solving tasks. This would constitute an additional line of enquiry in this field of study.

Finally, this type of study relates to the work on conformity and character carried out by Crutchfield (1955) which investigates the effects of conformity tendencies in various populations. This relates directly to what we have termed 'environmental' factors which are discussed below more fully in the final chapter.

(f) DEFERRED JUDGMENT (BRAINSTORMING)

Alex Osborn (1957) in his book Applied Imagination, also discusses inhibitors - perceptual, emotional and cultural blocks - to 'creative thinking'. Under perceptual blocks he draws attention to such matters as the students difficulty in isolating problems, difficulty from narrowing the problem too much, inability to isolate attributes, failure to use all the senses in observing. Under cultural and emotional blocks he emphasizes the effects of conformity, reliance on authority, and fear of making errors.

As a more positive educational measure Osborn introduces the concept of 'deferred judgment' or 'brainstorming'. In effect this method requires the student to attempt to "separate the process of producing ideas from the process of evaluating them". That is to say during the effort to generate ideas the student is encouraged to suspend his judicial process of evaluating them in order to allow the process of generation to develop more fully. Parnes (1959) (1963) in a controversial series of studies, has obtained experimental results which suggest that Osborn's technique of 'deferred judgment' is effective as a means of developing the student's production of ideas.

Parnes (1963) describes the 'deferred judgment' principle as one that calls for the deliberate separation of idea-production from evaluation. To quote: "In other words, during the effort to generate ideas, the judicial process is deliberately suspended; evaluation is deferred in order to allow full play to imagination". In an earlier paper, the 'brainstorming' method is described as follows: "In this method a subject is instructed to attempt to solve problems by recording all tentative solutions which occur to him, postponing judicial evaluations of those solutions to a subsequent time period". Parnes and Meadow (1959), Osborn (1957).

In the first of several studies Parnes and Meadow obtained results which suggested that a class group, instructed for one semester in creative problem-solving methods, increased its productivity in five of seven tests of creative ability as compared with a control group, Meadow and Parnes (1959).

A second study, Parnes and Meadow (1959),was designed to study the effects on creative problem solving (by untrained subjects) of instructions to express solutions without evaluation (brainstorming) and instructions which required only solutions of good quality (non-brainstorming). The design also allowed for a study of the effects of training in a creative problem-solving course emphasizing 'brainstorming'. Each group of subjects (one group untrained, the other trained) was given two problems designed to measure creative ability in two testing periods. One problem was administered under 'brainstorming' instructions; the other problem was administered under 'non-brainstorming' instructions. The quality of the solutions was later evaluated by a trained rater.

The major findings were that (i) Significantly more good quality ideas were produced under 'brainstorming' instructions than under 'non-brainstorming' instructions. (ii) The subjects trained in a creative problem-solving course emphasizing 'brainstorming' produced a significantly greater number of good quality ideas when using the technique than did the untrained students.

An additional result provided by the analysis of data suggested that there was a positive correlation between quantity and quality of ideas. This correlation suggests that the efficacy of 'brainstorming' in producing an increment in good ideas is possibly the result of the increased quantity of ideas encouraged by the method - at least in a cognitive problem of the type used in the present experiment. Parnes submits that "It is likely that in the customary course of daily thinking, some ideas are inhibited by individuals because of fear of criticism from self or others. The brainstorming instruction, in reducing this inhibitory factor, and encouraging a greater quantity of ideas, seems to increase also the number of good quality ideas produced. The findings are interpreted to indicate that the 'brainstorming' instruction is an effective method for increasing the production of good ideas in a particular type of creative thinking problem, and that it is even more effective if preceded by extensive training in its use".

In a later article, "Education and Creativity", Parnes (1963) submits that in addition to the teaching of creative problem-solving there have also been successful projects based on the integration of creative principles and procedures with conventional courses. Two examples of courses which have thus been modified are Jere Clark's economics course at the University of Chattanooga and Harry Hansen's marketing course at Harvard. Parnes suggests that "The value of such modifications has been indicated by research on the effectiveness of the similar incorporation of creative principles and procedures into courses in language arts".

To quote further: "Several special institutes and workshops have been held regarding the integration of creative problem-solving methodologies with the teaching of other academic subjects. The first was a one-day workshop at the University of Buffalo for teachers of American history. On the West Coast, San Jose State College has taken the lead with an annual five-day Creative Education Institute which offers graduate credit. At this Institute several hundred teachers devise ways to integrate creative methodologies within their respective subject-matter fields".

There are several criticisms to be made of the research carried out into 'deferred judgment' and 'brainstorming'. First, the experiments described do not evaluate in a controlled way the relative effects of prior training in the actual subject-matter of the problems themselves besides the effects of prior training in 'brainstorming'. Put briefly, this is the stage of creative thought described by Patrick, above, as 'preparation'. Preparation or prior learning is undoubtedly of major importance in any creative work. Without the collection, selection, and analysis of data and without some preliminary trial and error at one's task creative activity is unlikely to be productive. As we saw above from our brief consideration of Parnes' (1963) article "Education and Creativity" it was argued that there has been a successful integration of 'creative principles and procedures' with conventional courses. This work has not been described in detail however and there is clearly a need for controlled studies to be made. Secondly, it would be interesting to assess the value of 'brainstorming' procedures in various fields of study. As we have seen Parnes, above, argues that 'brainstorming' procedures are being introduced into various subject-matter fields. There is a need, however, for considerable further detailed investigation into both level and type of education.

Finally it would appear, at least from the literature, that the 'deferred judgment' procedures are most successful, or at least most readily accepted, when used in the 'group' situation of 'idea production' as opposed to the 'individual' situation. Parnes argues that this is a 'popular misconception', and that the fallaciousness of this impression is demonstrated by the fact that all measurements in the studies at the University of Buffalo were made on the basis of individual thinking, not on group collaboration.

In conclusion it is perhaps advisable to regard 'deferred judgment' or 'brainstorming' as an interesting although comparatively unexamined innovation in the techniques used to develop creativity and worthy of further research. It does not seem likely, however, that 'brainstorming' will reduce the need for the detailed and careful periods of preparation outlined by the earlier writers.

Regarding the distinction between group processes and individual processes it would be interesting to examine the research on 'brainstorming' in the light of some of the recent research into group behaviour. Meuwese (1964) for instance, in an extremely interesting study investigates some determinants of group creativity and group processes under varying conditions of stress. From his experimental work Meuwese concludes that "interpersonal attitudes and the intelligence of the group leader predict group performance on a creative discussion task, but the direction of the relationship is influenced by the type of stress under which the group is working". It would be interesting to investigate the influence of 'brainstorming' instructions in the light of research work of the type carried out by Meuwese. A bibliography on group studies is included at the end of the monograph.

Chapter 6. ENVIRONMENTAL FACTORS IN CREATIVITY

The task of isolating those environmental transactions which facilitate the development of the creative individual is bedevilled to an unusual degree by the now familiar criterion problem. Essentially the most readily available design involves isolating a criterion group which is then matched with an appropriate control sample and their reported experiences examined for any differentiating elements. The choice of criterion is thus of paramount importance.

In the light of Marks, Michael and Kalser's (1961) analysis of creativity in which a battery of 21 intellectual tests, creative attributes derived from peer evaluations on a situational rating scale and appropriate personality dimensions from a self-report inventory remained factorially independent of each other, evidence from researches which derive criterion groups by one or other of these means can only have a supportive role as the definitions of creativity used may be not merely operationally but substantively distinct. Furthermore even if creativity is defined in terms of one broad class of observations the use of discrepant operations of measurement could lead to discrepant findings. Holland (1961) and Holland and Nichols (1964) have specified creativity in terms of high level and relatively infrequent accomplishments in culturally significant areas of behaviour, for instance, collecting natural phenomena or designing original experiments in high school science. Such activities, of course, do not necessarily indicate an identical level of creative performance, with the result that the common scoring procedure of summing the number of items endorsed may not provide an entirely appropriate criterion measure for creativity; a high score might merely indicate that the respondent has engaged in many minimally creative activities. Skager, Schultz and Klein (1965) have compared such a score (quantity) with a rating of the level of the single most outstanding accomplishment (quality) in an experiment in which both scores were derived from the responses of 300 male freshmen to an Independent Activities Questionnaire. They found that the correlation between Quantity and Quality was only of the order of 0.4 in two separate samples and that quality was more related to a measure of academic aptitude while quantity was more related to a measure of intellectual stimulation in the home. Socio-economic status did not relate to either measure but they point out that their sampling effectively restricted the range of this variable.

Not even such seemingly objective criteria as number of patents accepted or professional distinctions received are entirely without important kinds of bias when environmental variables are under consideration. The problems at this level are indicated by Merton's (1968) findings of a 'family tree' among Nobel prize winners in science. Hargens and Hagstrom (1967) in an analysis of American academic science point out that membership of a prestigious scientific establishment, such as is involved in the Merton study, leads to a greater exposure and more ready acceptance of a scientist's innovations. In America, however, election to such an institution is a matter of sponsored rather than contest mobility; members are chosen just as much on their 'promise', that is the prestige of their doctoral institution, as on their demonstrated productivity. High prestige doctoral institutions tend to draw on high prestige undergraduate training centres and membership of these relates to social class.

This is obviously only one path among many but its existence should be acknowledged, especially as ratings of individuals on their degree of creativity consistently correlate highly (0.50 to 0.70) with ratings of productivity, sociability and 'success' and in the 0.20's with more objective criteria such as patents (Morrison, Owens, Glennon and Albright, 1962). As it is difficult to determine in which ways success will blur the criterion and as criteria of creativity are demonstrably heterogeneous it seems advisable to consider groups of successful creative people and use additional evidence from researches with different criteria in a supportive role.

Outstanding among studies of successful creative people is the work of MacKinnon, Barron and their associates at the Institute of Personality Assessment and Research, at Berkeley, California. As part of the country house weekend type of assessment that they have made of various groups especially of architects of demonstrated creative ability and often of considerable eminence, there has usually been included a life-history interview during which the subject is prompted to recall his childhood. MacKinnon (1960) reports that oversimplifying a tremendously complicated set of relationships they have conceived of two variables as centrally determinative of the functioning of the highly effective individual, emotional stability or personal soundness and originality of creativity of thought and action. People high on one or other of these dimensions report rather different early experiences. What MacKinnon has done with architects, Anne Roe (1951a, 1951b, 1953) has done with various groups of scientists ranging from anthropologists to physicists. Here again what we know of their early childhood experience is open to the bias of selective recall. This is of course the major drawback of the technique. The experience of success itself may have changed these men from what they were when still unrecognised and may have led to a concomitant revision of their perceptions of their childhood.

Only a longitudinal study can overcome this difficulty and no such study with creativity as the major variable has as yet been brought to fruition. However the Terman group of 1400 gifted schoolchildren, who scored in the top 1% in intelligence, of the school population of California have now been followed up for 40 years (Oden, 1968) and as they include 3 members of the National Academy of Sciences, 2 of the American Philosophical Society, 6 who are in International Who's Who, 46 in Who's Who in America, 10 in the Dictionary of American Scholars, and 81 American Men of Science they have obviously enjoyed a considerable degree of success. Their creativity is amply illustrated by their production of 2500 learned articles, 200 books, 350 patents, 350 miscellaneous articles, 400 short stories, 55 essays and a scattering of musical compositions quite apart from professional journalism and the production of scripts for films, television and radio. As a subsection of her report Oden (1968) reports the correlates of vocational achievement among gifted men by comparing the top and bottom 100 men from her sample of about 800 ranked on a composite criterion based mainly upon opportunities for the use of intelligence in the chosen vocation but taking into account the professional output, leadership, influence and initiative, recognitions and honours and earned income relative to an appropriate reference group. It should be noted that the low scoring group were not all unsuccessful in their own eyes. Some had deliberately opted out of any struggle for success, feeling that happiness could be more surely found in their avocational interests. With this rider then the Oden study provides valuable backing on MacKinnon's analysis in that much of the data was collected long before the groups diverged.

The Home Background of the Creative Person

Various claims have been made for the effectiveness of such basal factors as birth order and family size. MacKinnon (1960) reports that his group of highly effective individuals had more siblings and were more friendly with them. Cicirelli (1967) found no relationship between family size and concurrent tested creativity but did find that performance on verbal creativity tests was enhanced for groups with siblings of like sex close in age in a two child family. Roe (1953) notes a greater than chance incidence of first born children among her sample of 64 scientists which accords with a similar finding by Cattell and Brimhall (1921) on a sample of 855. However, Datta (1967) in a well controlled study of 536 male high school seniors rated as high, middle or low in early scientific attainment, found that the hypothesis that early scientific attainment is associated with being an eldest child was not supported although his criterion of attainment was sensitive to other differences among the groups. The study does suggest that there may be an inhibiting influence on the younger son who is more isolated, yet for a considerable range of family size, sibling sex, sibling separation and ordinal position combinations any 'favourable' effect of one ordinal position appears to be as susceptible to attenuation by other influences as any 'unfavourable' effects of another ordinal position. The general trend of his results lends support to Schachter's (1963) suggestion that birth order effect as shown by predominance of first borns among eminent men is an artefact of lack of appropriate control groups.

MacKinnon's sample report little childhood illness or accident which was also the experience of 90% of Oden's successful men as against only 68% of her unsuccessful group. On the other hand Roe (1953) in a study of eminent scientists notes that a significant number of physical scientists had endured long periods of relative isolation during childhood as a result of a serious illness. This, however, she related to the kinds of psychological accommodation peculiar to this subgroup who use withdrawal as a solution to interpersonal problems, especially problems involving aggression (Mclelland, 1963).

Roe also reports discrepant findings from scientists this time for a sample of social scientists (Roe, 1953) in that they came from non-integral families in a significant number of cases. MacKinnon's (1960) personally sound group and Oden's (1968) successful men in the vast majority of cases had the advantage as children of a home undisrupted by death or divorce, nor even, MacKinnon reports, by economic hardship. The latter variable produced no significant difference in Oden's survey but it is backed up by a sociological assessment of the family environment of the 'intelligent' and 'creative' children from the Getzels and Jackson study reported earlier, in which of course the validity of the criterion is open to grave doubt. (see p.10). They found that the parents of the 'creative' children significantly less often spontaneously referred to earlier financial hardship. (Getzels and Jackson, 1961). This may have been a personality difference or a function of length of education in that they found a much higher incidence of academics and a far greater professionalization of education among the fathers of the non-creative group.

The latter finding is in itself abberant and may well be due to their highly restricted sample. Weisberg and Springer, (1961) in a more adequately sampled concurrent study of 32 children whose IQ's were among the top 50 of a sample of 7000 public school children and who were then differentiated on three of the Minnesota Tests of Creative Thinking, found a positive relationship between child's tested creativity and father's occupational autonomy.

Oden's successful group came in 40% of cases from a professional background where father and even the grandfather had had some college education, where books were valued (38% had a library of 500 or more) and where the father held positions of honour and trust in the neighbourhood. MacKinnon's architects also came from families where there was a plentiful supply of successful and respected relatives as suitable models for identification (MacKinnon, 1965b) and in this respect Roe's sample is also in agreement. They again showed an incidence of professional families out of all proportion to their representation in the community as a whole and early feelings of personal or family superiority on a social or intellectual basis were common. (Roe, 1953). That such a situation obtains regardless of specialism is supported by a well controlled study by Schaefer and Anastasi (1968) of 400 American high school boys. The boys were subdivided into creative and control groups in artistic and scientific fields on the basis of teacher nominations supported by specific creative products and by an above cut-off point score on two tests of creativity. They found as correlates of creative activity regardless of field a familial background which was academically superior, parents who provided role models of interest in the student's field as evinced by the magazines taken in the home, and fathers whose favourite leisure occupation was reading.

Such professional people have fairly well-defined attitudes to education and some of the most striking differences between Oden's two groups are to be found in their recollections of this area.

With regard to school progress 59% of the successful group were encouraged to forge ahead while only 39% of the nonachieving group were so encouraged. On the other hand 61% of the latter group were allowed to go their own pace as against only 40% of the achieving group. 15% of the parents of the achieving group demanded high marks, three times as many as in the other group and a further 73% encouraged them while only half the parents of nonachievers did so. On the other hand 34% of the parents of nonachievers took high marks for granted and a further 7% shared little concern, a feature entirely absent from the achieving group's experience. At the end of schooling 96.5% of the achievers' parents encouraged college attendance and only one case was reported of indifference. In the other group such cases accounted for 16% of the sample, while a further 22% did not encourage further education, almost all for financial reasons. Roe's (1953) sample of 64 eminent scientists provides firm substantiation for the situation obtaining among successful people; in almost all homes, regardless of parental occupation, learning was valued for its own sake.

The important variable however is the response of the child to these parental attitudes. Judging from the Oden data there appears to have been some differential process at work in the two groups. Whereas two thirds of the successful group expressed much interest in academic success in their teens by the time they were in their twenties three quarters espoused such interests. But in the unsuccessful group while just over half express a strong interest in their teens the figure falls to 42% in their twenties. The explanation for this differential trend in need for achievement has not been explicitly sought by Oden but the classic conceptualization of n ach as arising from early opportunities to master difficult tasks and from rewards for mastery accords well with the degree of encouragement given to the successful group and the obverse of n ach, motive to avoid failure, which is hypothesized to be related to parental encouragement of dependency and punishment for incompetence sits well with the unsuccessful group's being allowed to set its own pace. Unfortunately attempts to validate the relation of n ach to child rearing practices in longitudinal studies have proved disappointing. Feld (1967) found that n ach in adolescence was not strongly related to concurrent or earlier maternal attitudes and Bartlett and Smith (1966) report that n ach in a sample of 31 boys aged 8 to 10 appeared to relate to the frequency with which mothers expressed disappointment with unsatis factory behaviour; and the infrequency with which expressions of love were used as a reward.

Whatever the mechanism it appears that Oden's successful group have by and large espoused the achievement motive, while her unsuccessful group have failed to confirm. This latter non-conformism is popularly recognized as a mark of the creative character but as Crutchfield has demonstrated conformity is not a unitary concept.

Crutchfield (1962) presents an operational definition of conformity based upon experimental conditions in which the subject must express a judgment. The subject's private conviction is clearly at variance with the group consensus and conflict ensues. If he expresses his own deviant judgment the subject remains independent of the group consensus. If he expresses agreement he is conforming. Hence this is not merely social uniformity of behaviour. There are differences in type and nature of conformity in different persons under different conditions. On the one hand there is a readiness to assume the group is correct in which there is a shift in the individual's private as well as expressed judgment. For example Wyer (1967) in a study of the conformity of persons of different degrees of academic achievement where two incentives to conform, achievement and affiliation, were used found that those subjects who had low ability and low achievement showed the highest conformity. Secondly there is 'expedient' conformity where the inner judgment remains the same. One might imagine that in the Wyer study the high ability high achievement group who showed medium conformity did so in this way. There are also two types of nonconformity, 'true' independence on the basis of strong inner conviction and self-confidence and counterconformity which is a kind of reaction showing influence by the group but in a different direction, something of a repudiation of or an attack on the group. Whereas overachievers had low conformity under both conditions of incentive in the Wyer study, underachievers showed a particular tendency not to conform under achievement incentive conditions.

The conformist is obviously unlikely to make a creative contribution. Assailed by doubts about personal adequacy he is reluctant to express ideas that diverge and Crutchfield suggests that he may fear the creative attempt. The expedient conformers although they are in effect reserving their own opinions are in such a position of cognitive dissonance that they too will eventually give in. The counterconformist is assimilated by society in a different way in Crutchfield's scheme. In indulging in difference for difference sake his creative efforts can be fatally cut off from the consensual validation required of creative effort and be directed at superficial outer appearances - the Bohemian role. Such a role becomes semi-official and so society re-envelops him, 'decontaminating the dissident'.

Crutchfield produces ample evidence that lack of conformity is indeed a correlate of creative production. He reports normative data demonstrating that research scientists in industry are less conforming than male college sophomores who are in turn less conforming than military officers. Moreover his most creative research scientists are less conforming than those who have a poorer productive record.

What then are the interpersonal transactions which facilitate these two important characteristics of the effective creative individual, the desire to achieve and to achieve without compromising his own beliefs. Oden's (1968) data offer little help in this direction. Admiration for or rebelliousness toward the parents, affection and understanding between subject and parent, the subject's feelings of rejection by the parent, a tendency to be overprotective or solicitude on the part of the parents, none of these variables differentiated her two groups. Other studies, however, find one or other of these variables associated with later creativity and almost all are in agreement with Oden's one significant finding in this area, that success was associated with great encouragement toward independence and lack of it with lack of success.

Roe's (1953) psychologists and anthropologists report patterns of firm parental control with frequent overprotection leading to rebelliousness on their part. In their Thematic Apperception Test responses they display a general helplessness in the face of severe problems and a heavy dependence on parental figures. Eiduson's (1962) sample of eminent scientists also remembered possessiveness and aggression in childhood especially on the mother's part; they had little contact with their fathers whom they described as rigid and aloof. Finally MacKinnon (1960) reports that those who scored higher on a composite index of creativity tended to feel that their home life had not been as happy as most others. Some endured the most brutal treatment at the hands of sadistic fathers. "There is, however, some evidence that those who were harshly treated in childhood have not been so effective or so successful in their professions as those who were more gently treated." (MacKinnon, 1960).

But in a later article MacKinnon reports that on the whole "what appears to have characterized the parents of future creative architects was an extraordinary respect for the child and confidence in his ability to do what was appropriate. Thus they did not hesitate to grant him rather unusual freedom in exploring his universe and in making decisions for himself - and this early as well as late". (MacKinnon, 1962a). A similar finding is reported by Drevdahl (1964) for psychologists and Nichols and Holland (1963) found the same situation obtaining vis-à-vis literary and musical achievement among first year college students. Literary achievement was significantly related to non-authoritarian child-rearing attitudes on the part of the parents. Students who were successful in these spheres came from homes marked by high levels of parental tolerance of ambiguity and low levels of parental self control. Such evidence does not sit well with Roe's findings of overprotectiveness and indeed this has been isolated as a debilitating factor especially in relation to the mother. MacKinnon's (1960) non-effective group more often had mothers who were seductive, demanding and overprotective, Weisberg and Springer (1961) found that compulsive mothers tended to have less creative children and Getzels and Jackson found that the mothers of their uncreative group were more likely to be vigilant about the 'correct' (according to external criteria) upbringing of their children.

The corollary of the effective autonomy of the creative child is a lack of intense closeness, of strong emotional ties with one or both parents. That this is the general case is reported by MacKinnon (1962) for architects, Stein (1963) for research chemists and Drevdahl (1964) for psychologists. But even though the weight of available evidence runs contrary to Roe's findings this may actually be a case of a genuine differentiation in experience between scientists and others. Schaeffer and Anastasi (1968) report that the creative Arts oriented adolescent boy's relations with his parents appear to have centred more often on shared interests in artistic and literary pursuits and less often on a warm personal relationship than those of the control subjects. The creative arts boys described their mothers as enthusiastic rather than understanding or sincere (MacKinnon notes the high incidence among families of creative architects of distinctly autonomous mothers who led active lives with interests and sometimes careers of their own apart from their husbands'), and if they had personal problems they were more likely to seek help from 'several persons' than from the mother. On the other hand the creative science boys in this sample and their parents showed some evidence of 'conventionality' (Schaefer and Anastasi, 1968); they were less likely to be migrants or have travelled, gave evidence of a much stronger sex-role identification and the boys resembled the academically superior student much more closely than did the creative arts boys. These differences are even more striking when considered in the context of the evidence regarding factors relating to discrepancies between verbal, numerical and spatial abilities in children. (Bing, 1963; Ferguson and Maccoby, 1966). Enhanced verbal ability on convergent tests is fostered by a close relationship with a demanding and somewhat intrusive mother leading to a continued and somewhat conflictful dependency on adults while enhanced non-verbal convergent abilities are associated with a childhood where a considerable degree of freedom to experiment on one's own is allowed. These relationships are almost precisely reversed when discrepant creative abilities are considered. It is little wonder that Oden found no significant effects when comparing her two heterogeneous groups; intelligence is her fundamental criterion, not creativity. As for the other researches it seems that MacKinnon's conclusion based on architects speaks for all except some kinds of scientists: "The expectation of the parent that the child would act independently but reasonably and responsibly appears to have contributed immensely to the latter's sense of personal autonomy which was to develop to such a marked degree". (MacKinnon, 1962a).

Supporting evidence for this as the key variable comes from studies of cognitive differentiation which has been suggested by Haronian and Sugarman (1967) in a theoretical review to be a necessary but not sufficient condition of originality and imagination. MacKinnon (1960) reports having used successfully various perceptual tests basically involving field dependence/independence a dimension of cognitive differentiation (cf. Witkin et al, 1962) to distinguish between his creative and less creative groups and further empirical evidence is provided by Spotts and Mackler (1967) who found that individuals with field independent cognitive styles were consistently more creative on a battery of divergent tests than were those with field dependent orientations; relationships between creativity tests and intelligence were weak and typically nonsignificant. Evidence about the child rearing practices associated with this variable is provided by Dawson (1967) who in a study of two West African tribes, the Temne and the Mende, draws out a striking contrast between two cultural milieux which are associated with widely differing levels of field dependence. The Temne place great stress on conformity to adult authority, are mother dominant and oriented to tradition. The Mende are less mother dominant, less tradition oriented, use deprivation rather than physical punishment as a control and give the child responsibility at a very early age. The Temne are more field dependent than the Mende. Dyk and Witkin (1965) found essentially the same relationships holding among the Jewish middle class in New York. In a review of this dimension (Witkin et al, 1962) mothers of field dependent children were described as interfering with separation, preventing the assumption of responsibility and stressing conformity. In contrast, mothers of field independent children encouraged them to assume responsibilities and activities in keeping with their age.

Probably the most appropriate conceptualization of these and the previous interactions reported is to be found within the framework of conceptual systems theory (Harvey, Hunt and Schroder, 1961). The theory proposes that a person's concepts are ordered according to certain patterns of organization. It is assumed that one of the most important structural characteristics of this organization is its degree of abstractness or conceptual level. A person at a high level is more likely to explore situations and to be creative and adaptable when faced with a changing environment. In contrast the person at a low level manifests thinking which is stereotyped, overlearned and dominated by the rules of authority. According to the theory optimal environmental conditions which allow the highest levels to be reached are characterized by maximum information feedback and allow the person to learn from the feedback. Harvey et al.

(1961) refer to these as interdependent. An environment which forces the person to fit a preconceived mould or to attain a completely externally determined standard would inhibit conceptual development, it is referred to as unilateral. In a validation study of this aspect of the theory Cross (1966) points out the similarity of the unilateral-interdependent dimension to Schaefer's (1959) autonomy-control dimension which has frequently emerged as greatly important in factor analyses of parental attitudes. Cross compared this dimension and a second less important one of love/hostility with the conceptual level as measured by a sentence completion technique of 377 boys aged 14 to 18 in a junior-senior high school. Unilaterality-interdependence of the parents was ranked on a five point scale from both interview and questionnaire data. Score 1 meant that the parent was in complete control. Standards came only from the parent and were imposed by the parent who tolerated little or no deviation. Score 5 was awarded if the parent influenced only through dissemination of factual information. The child takes what is necessary and determines his own standard. The parent looked for information from the child and permitted all feedback, even to the point where the child's welfare might be in danger.

Three patterns of analysis were used. Matched pairs of extreme conceptual level groups were tested for parental differences, extreme groups of parents were formed on non-authoritarianism and warmth and differences in the conceptual level of their sons were observed, and finally correlational analysis of all available responses was used. The relationship between parental training conditions and boys' conceptual level was confirmed by all three methods. "From a conceptual systems view, a person in a training environment which is interdependent obtains maximal feedback from his success and his errors; therefore, he gains a realistic perspective, i.e. he acquires the appropriate dimensions needed to evaluate and respond to input from the environment. Parents who grant their child a great deal of autonomy allow him to learn about the environment on his own terms. By tolerating different points of view, they permit and encourage divergent thinking and diversity in the child so that he learns different patterns of dealing with the world. Unilateral training precisely restricts this kind of learning." (Cross, 1966). There was no difference in acceptance between mothers of high and low conceptual level boys and an effect for fathers was produced in only one analysis.

These findings fit well with the relations with parents described by highly successful and by highly creative individuals and provide a coherent explanatory theory of the mechanisms involved. How good can be seen by consideration of the following two case studies reported by Cropley (1967). They were selected on the basis of an extreme bias toward convergent or divergent thinking as measured by tests but display most of the features of more valid samples. Here is one of them.

"Tom had been raised from an early age by his mother alone. She was an energetic woman who dominated the boy at all times. She told him when he might play, when he must do homework when he must read 'good' novels, and so on. She insisted that he must play chess with her at a given time each evening, insisted on a certain schedule for piano practice and ran his life completely. She administered severe corporal punishment for trivial offences, and was, overall, domineering, controlling intrusive and authoritarian." (Cropley, 1967). Tom was a brilliant student at school and university; he has made no contribution, either theoretical or empirical to his profession.

The School Environment

Research in this area has centred on children who do well on divergent thinking tests, the validity of which is almost entirely a matter for conjecture. When the peculiar difficulties in assessing precisely what is happening in a classroom are further taken into account, it becomes obvious that any conclusions about classroom interactions can only be tentative.

The most readily quantified aspect of such interactions is the question-asking behaviour of teachers. This has been explored by Burkhart (1962) using a test which required of a sample of teachers in training that they ask divergent questions about an object after they had been offered a definition of divergent thinking and an exemplar:- 'Why did God choose the apple to tempt Eve in the Garden of Eden rather than some other fruit?' The majority of Burkhart's sample proved unequal to the task and in some cases produced lists of 40 or 50 unfailingly convergent questions. They realized that they were doing so but could not break their set. Such teachers tended to run highly evaluative classrooms, evaluative in the sense that a deliberate repudiation of it constitutes brainstorming. Torrance and Hansen (1965) report that over 90% of the questions asked by a sample of junior high school social studies teachers called only for the reproduction of textbook information. From a sample of 29 business teachers they selected the top and bottom 6 on a composite measure of tested creativity and made observations of their behaviour over five class sessions spread at random throughout a term. Their questions were classified as Factual-reproductive or Divergent-provocative. Less than 1% of the questions asked by the low creative group fell in the latter category, while in the high creative group slightly more than 10% of the questions were of the divergent-productive type.

In a study of high school climate in two schools judged to be creative and two to be traditional Walker (1967) found that in the classroom, teachers exhibited more stimulating-original behaviour, students exhibited more initiating behaviour, and there was more evidence of activities of a creative nature. Presumably this is why these schools were chosen. There was no difference however in student performance on factors believed to be of importance in creativity and the attitudes of highly creative students toward their school experience was not significantly more positive.

On the other hand Yamamoto (1963) failed even to find any difference in classroom behaviour of high and low creative teachers though it should be noted that he dichotomized his group of 19 teachers on tested creativity rather than occluding the middle. He was concerned to demonstrate that more creative teachers can provide a classroom environment more conducive to the pupil's whole development and the obverse of such a view, that the development of creative children is held back by the less sensitive approaches of less creative teachers. However, none of his classroom observation methods revealed any differentiating classroom behaviour patterns, nor did tutelage by one or other group affect the personal adjustment of the pupils. There were no differences in pupil achievement in reading but in arithmetic the combination of low teacher creativity and low pupil creativity resulted in the highest achievement while the combination of low teacher creativity and high pupil creativity yielded the worst results. Finally pupils at both ends of the creativity continuum suffered under the instruction of the high creative group of teachers. In the light of the differential performance of the convergent thinking group under the two kinds of instructor it would appear that there must have been differences in classroom behaviour which the methods of assessment either ignored as irrelevant or were not sufficiently sensitive to pick up. Torrance in a reanalysis of the data did find classroom behaviour differences in the hypothesized directions (Yamamoto, 1967) but this was a comparison between the top and bottom scoring teacher; working with groups of one smacks of desperation. From this data it must be assumed that if there are interactions of teacher creativity and pupil creativity they are complex and by no means always advantageous.

There is, however, a more fruitful heuristic method, the identification of groups of teachers not in terms of person, but of process. Wodke and Wallen (1965) having derived a factor score, warm permissive vs cold controlling, from Q-sorts of 24 dimensions of teacher behaviour then chose 8 extreme scorers on this dimension from a sample of 77 elementary school teachers. 32 pupils representing two levels of pupil creativity and two grade levels were rated by two independent observers on 14 pupil behaviour dimensions. The only significant effect (at the 10% level) was that both highly creative pupils and pupils of highly controlling teachers exhibited less self-initiated verbal behaviour.

The apparent irrelevance of such a dimension in the school situation is borne out by Rippey (1965) who failed to establish any difference in achievement in English grammar, punctuation and usage as a result of interaction between pupils' personality needs and two dimensions of classroom instruction, structured/instructured and dialetical/errorless teacher (socratic-formal lecturing). He concludes that it is probable that the children provided internal controls which resolved the lack of congruence between need and reality. Such independence of the affective environment chimes well with Cross's (1966) finding that love/hostility in parents was not associated with conceptual level in the child.

There is, however, a well substantiated relationship between teaching method to which Harvey, Hunt and Schroder's (1961) interdependent/unilateral dimension can be readily applied and the tested creative abilities of children. Macdonald and Raths (1964) split an elementary school year group into 3 creativity levels (as assessed by tests) and in effect streamed by creativity rather than by intelligence. Each group was given 12 tasks, 3 of each of 4 types - frustrating, open, closed and passive. Group involvement was judged by raters and the children also rated each task on a like/dislike dimension. They conclude that pupils who are low in creative thinking abilities tend to dislike frustrating curriculum assignments and to respond in an unproductive way to freedom from compulsive closure and a strong desire toward ultimate closure, passionate commitment and cool detachment. To enhance this ability Crutchfield adopts a 'creative-acts-in-miniature approach'. By undertaking a series of meaningful creative problems of some complexity and being guided step by step through the instructional program to a final successful solution of each problem trained children surpassed control children for every one of the different specific attributes of effective problem solving which Crutchfield measured, question asking, sensitivity to discrepancies, generation of many good ideas and utilization of clues, and also in the ultimate pay-off, getting an idea that gives an actual solution. Five months later there was still a clear, though reduced superiority. Crutchfield qualifies his striking results with one rider: "it may be that almost any honest intelligent, and direct effort made by the teacher to arouse and guide the child's interest in problem solving, and to give him ample opportunities to practice it and to discover that he can succeed in it, will produce substantial gains".

Such approaches are typified by the idea of the responsive environment due to O. K. Moore (1961) in which children are propelled by their own curiosity, the adult or the environment only responding promptly to the child's efforts to learn. Moore has used a modified electric typewriter to show that preschool children can learn to read, write, type and take dictation without having to undergo the traditional rote learning experiences. A much more ambitious environment has been created by Karlins and Schroder (1967) for the Inductive Teaching Program, a computerized technique which requires the subject to become an active manipulator of the informational environment and to utilize the information in that environment to come to conclusions and make decisions which are not pre-judged for him by external sources. Research relevant to the present problem is promised by Karlins but it is not yet available. However the discovery method in learning in Mathematics has recently been the subject of a well controlled study by Worthen (1968) in which although inferior to expository methods in the facilitation of immediate learning it was shown to be superior in retention in the transfer of heuristics, behaviours valuable in creative performance. Moreover it is arguable that such accommodations in harnessing curiosity as their motive power lead to greatly increased richness in learning. Paradowski (1967) has demonstrated that curiosity facilitated both intentional and incidental learning and Laughlin (1967) has shown that such incidental concept learning is positively related to tested creativity while in his experiment remaining relatively independent of differences in high level verbal abilities. Such evidence provides further substantiation of Schroder, Driver and Streufert's (1966) theory of creativity which emphasizes the basic role of discovery teaching, interdependent training in their terminology, in the fostering of individual creativity.

In sum it appears that creative development can be enhanced through the use of discovery methods in a subject matter course and as Sommers (1961) found in industrial arts training may even lead to superior performance in subject matter as well as gains in creative productivity. The nurturant environment both at home and in school is one which gives a free reign and a ready response to the explorations of the child. It is the more unfortunate then that in five countries, the U.S.A., Germany, India, the Philippines and Greece, open and frustrating tasks whereas 'pupils who are high in creative ability tend to dislike closed tasks'.

Further light is thrown on these findings by a literature review by Torrance (1965b) in which he reports that McConnell in 1934 found that an IQ test correlated more highly with achievement in second grade arithmetic taught by authoritative identification than when it was taught by the methods of discovery advocated by many Progressive Educators at the time. Furthermore Hutchinson in 1963 in a study involving learning in junior high school social studies also found that under traditional authoritarian teaching there is a significant positive correlation between mental age and achievement but none between tested creativity and achievement, under experimental conditions offering considerable opportunities for learning in creative ways the bias in the relationships was reversed. Gotkin and Massa found a significant negative correlation between tested creativity and achievement based upon programmed instruction in language arts. On the other hand Stolurow found a higher positive correlation between tested originality and achievement than between mental age and achievement after programmed instruction in mathematics and statistics. Torrance concludes; "the difference was that Gotkin and Massa used programmed materials that permitted only tiny mental jumps and gave little opportunity for making, identifying and correcting errors, while Stolurow's programmed materials emphasized a trouble-shooting or hypothesizing approach that builds specific but multiple associations to a stimulus". (Torrance, 1965b).

It appears then that under instructional methods which optimise their abilities creative children enjoy themselves to a greater extent. The claims for such methods go further however in that it is suggested that by suitable instruction creative abilities as measured by tests can be enhanced. Parnes and Brunelle (1967) in a review of 40 studies evaluating programs for teaching students to improve their sensitivity, fluency, flexibility, originality and elaboration report that approximately 90% of the total number indicate that subjects' creative production levels were significantly increased by deliberate educational programs.

In a research by Torrance (1961) children in the first three grades of elementary school received training in how to produce ideas and in the second and third grades trained children consistently produced performances on Torrance's creativity tests superior to those of untrained children. Torrance's method involved teaching the children a set of principles which govern idea production.

A clear and explicit account of an approach using programmed instruction to the training of creative problem solving ability is set out in Crutchfield (1966). He concentrates his attention on what he calls a 'master thinking skill'. "This refers to the creative person's basic ability to plan, organize, mobilize and deploy his repertory of specific skills in optimal attack on a creative problem." (Crutchfield, 1966). It is through its exercise that the creative individual is able "to maintain a constant and always precarious balance between the conflicting and competing demands that arise out of the inherent antinomies in the creative process", fluency and evaluation, divergence and convergence, Torrance (1965a) found strong disapproval of question asking, getting preoccupied with tasks, having the courage of one's convictions, being independent in judgment and thinking, willing to take risks and unwilling to accept authority's dicta. On the other hand, these cultures seem to lavish unduly great rewards for being courteous, doing one's work on time, being obedient and popular or well liked by one's peers and being willing to accept the judgments of authorities.

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A SELECTED BIBLIOGRAPHY

The following selection of references has been included to facilitate further inquiry into some of the areas of interest dealt with above. Mainly for purposes of expedition and convenience the items have been grouped into sections. While the section headings tend to follow the general pattern formed by the subject-matter of the chapters above, care has been taken to include references from lines of country not dealt with in detail, or with emphasis, in the review. In particular, additional sections on 'problem-solving' and 'group processes' have been included, along with a section on 'general and theoretical analyses of creativity' and 'creativity in arts and sciences'.

While pains were taken in selecting the following references from the large numbers collected by the authors in the course of their study, it was inevitable that a number of interesting items had to be omitted. A large-scale bibliography is now being compiled at Manchester.

CONTENTS

1. General and Theoretical Analyses of Creativity.

2. Studies of Creativity in Arts and Science.

3. Personality and Intellectual Characteristics in Creativity.

4. The Development of Creativity.

5. Environmental Studies.

6. Studies of Problem Solving in Creativity.

7. Group Processes and Group Effectiveness in Creativity.

8. Tests and Measurement in Creativity.

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Printed by Direct Design, Christchurch, Hants.